JUNE 1961

World Oil

EXPLORATION • DRILLING • PRODUCTION

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JUN 13 1961
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ACTIVITY AND TECHNICAL REPORT ON OFFSHORE OIL AND GAS OPERATIONS

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What's ahead for offshore oil? 79
Mohole–a technical report 84
New rig cuts offshore costs 102
12-year look at stripper wells 140
Australia's exploration boom 143

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FOR EXPLORATION, DRILLING AND PRODUCING ENGINEERING OPERATIONS AND MANAGEMENT

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QUICK LOOK at this issue

To help you put first things first, scan these time-saving digests, checking those you want to read first.

INTERNATIONAL OFFSHORE REPORT

☐ **What's the Free World offshore oil and gas outlook? . . .** Activity is expanding to a growing number of offshore areas, including South America, the Persian Gulf, Western Europe, Africa, and the Sea of Japan. For the most complete report yet published on current offshore activity off the coast of North America and other key areas, turn to . . . . . **Page 79**

☐ **First phase of Mohole project proves successful . . .** The CUSS floating vessel has just finished coring six holes with the deepest 601 feet below the ocean floor. The water was 11,700 feet deep at the location, with sea swells ranging from 6 to 14 feet. The ship did not move more than 350 feet from its intended position, even though there were periods when the winds were greater than 25 miles per hour. For an informative report on the first phase of the Mohole project, turn to **Page 84**

☐ **Which shows faster payout: platforms or underwater completions? . . .** In this exclusive WORLD OIL interview, officials of two offshore companies give their candid opinions on the merits of platforms versus underwater completions drilled from floating units. For a highly informative discussion of these two offshore operations, turn to . . . . . **Page 91**

☐ **How to evaluate pipe stresses when drilling from a floating vessel . . .** These stresses include bending due to the roll of the ship, displacement of the ship over the hole, and ocean current drag force. For a detailed discussion of these conditions and how they may be calculated from formulas which were developed from extensive drilling operations off the coast of California, turn to . . . . . **Page 95**

☐ **New rig reduces well remedial costs offshore . . .** Williams Drilling Company's new skid-mounted concentric tubing workover rig is completely equipped with 87-foot mast, double drum drawworks, twin diesel engines, hydraulic rotary table, triple pump, and 40-barrel capacity slurry tank. Unit can operate on 15x20-foot offshore platforms, requires only a small derrick barge for installation, see . . . . . **Page 102**

☐ **Salt dome refraction survey aided by double-jug layout . . .** More recent modification of an older system of determining configuration of salt domes provides for running two geophones in deep wells, with

one jug at the bottom of the hole and the other up the hole 500 or 1,000 feet. Equipment is carried on a trailer-mounted reel operated by hydraulic motors. For offshore work, the reel assembly slides off the trailer, then is transferred to a boat and delivered to the rig. See ..... Page 106

☐ **How to operate offshore production by remote control . . .** New Gulf Oil Corporation automation project off Texas coast remotely controls wells, gas flow rates, production unit temperatures, and chemical pumps. Onshore pumper also can monitor entire production operation including status of platform security. Automatic alarm system reports any difficulties. For complete details, see ..... Page 107

☐ **High density packer fluids pay off in South Louisiana . . .** Dense salt solutions have distinct advantages as completion and packer fluids. For example, plastic sand consolidation treatment success ratios are higher, perforations are cleaner and there is no solidification or settling of the fluid above packers which can complicate workover jobs. This article describes Conoco's experience with dense (up to 14.0 ppg) brines. See ..... Page 113

☐ **Some commercial oil, gas indigenous to Pleistocene . . .** In offshore Louisiana several significant and widely-separated fields have good reserves of oil and gas which apparently are indigenous to Pleistocene sediments. Upward seepage from older beds is minor. These conclusions are of great importance to Pleistocene prospects in continental shelf areas over the entire world ..... Page 122

☐ **How safety is designed into offshore platforms . . .** Detailed engineering studies have enabled Gulf of Mexico operators to establish an enviable platform safety record. More than 1,000 structures have been erected in Gulf operations. Although some have been damaged by high seas and ship rammings, not a single platform has collapsed. For details on platform design considerations, see ..... Page 131

☐ **Industry is achieving full recovery of earning power.** The first half of 1961 is proving to be generally the most profitable six months of the past four years. Some companies are setting new records. Earnings probably will continue good in the latter half of this year. But year-to-year increases will not be as sharp as those in the first and second quarters of 1961 ..... Page 138

☐ **Stripper wells account for larger share of U. S. crude production . . .** During a 12-year period, U.S. stripper wells increased their share of total production from 15.1 percent to 21.4 percent—decreased in percentage of total wells from 72.9 percent to 66.7 percent—and decreased in percentage of total crude oil reserves from 36.3 percent to 23.5 percent. For complete details on the changing role stripper wells are playing in the U.S. oil economy, turn to ..... Page 140

☐ **Increasing exploration brightens petroleum prospects in Australia . . .** An exploration boom is a definite possibility. A sharp increase in drilling doubtless would follow any commercial discovery. Activity already has been stimulated by significant flows of gas lately from several wells in Queensland.

Australia has many promising sedimentary basins with favorable structure. Possibilities of commercial oil and gas have been greatly enhanced by increased application of modern exploration methods during the past few years ..... Page 143

Many $$-Making Ideas—Coming in July

FOLLOWING ARE JUST a few of the outstanding technical and economic articles you will be reading in July WORLD OIL.

Lithologic zoning of dolomites helps find oil . . . John P. Hobson, Jr., research geologist and project leader for Cities Service Research and Development Company, shows how better lithologic descriptions of cores and outcrop samples would aid greatly in the search for oil and gas in carbonate rocks.

How to determine equity percentages in unit operations . . . A well known petroleum engineer and geologist present a time-saving method to determine equity percentages that produces accurate results, and is applicable in areas involving many small properties.

New foaming agents aid air/gas drilling . . . Two top researchers with Pan American Petroleum Corporation show, through case histories and results of several hundred tests, how new foaming agents have opened new areas of operation for air-gas drilling.

How oil and gas operators can meet today's economic challenge . . . H. F. Beardmore, vice president, Gulf Oil Corporation, presents a challenging message to all oil and gas operators, including those who would blame their troubles on others.

To make a long story short—be sure to read WORLD OIL next month, and every month, for the industry's most authoritative technical operating, economic and international oil and gas coverage.

Invite your friends to read it, too.

Watch for your International Outlook

Oil Industry in Brief

Here are the latest industry trends, revealed by WORLD OIL and industry research.

Earnings improve. During first quarter, 41 oil companies reported aggregate profits of $892,519,000—up 14.2 percent over same 1960 period for the most encouraging report since 1957 Suez Crisis . . . See Page 138.

Productive capacity increases. In January 1960, U.S. wells were producing crude at 68.3 percent of 10,585,000 barrels per day capacity . . . See Page 7.

Crude production decreases. Output averaged 7,232,000 barrels daily in April, down 1.5 percent from March, but up nearly 3 percent over April 1960 . . . See Page 13.

Imports drop sharply. Crude oil imports averaged 879,000 barrels per day in April, down 21.7 percent from March and 22.1 percent from April 1960. Total imports averaged 1.7 million barrels daily, down 21.9 percent from March and 12.2 percent from April 1960 . . . See Page 13.

Demand down slightly. Total petroleum demand was down 0.7 percent during first four months, but April total was up 4.5 percent from same 1960 period . . . See Page 13.

More operating rigs. At April's end, 3,317 rigs were operating, up 4.4 percent over March, but down 6.3 percent from April 30, 1960 . . . See Page 17.

Completions increase. New completions averaged 117 per day in April, same as March, but 2.6 percent better than April 1960 average . . . See Page 17.

Issue August 15

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GPC PUBLICATIONS

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.
PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.
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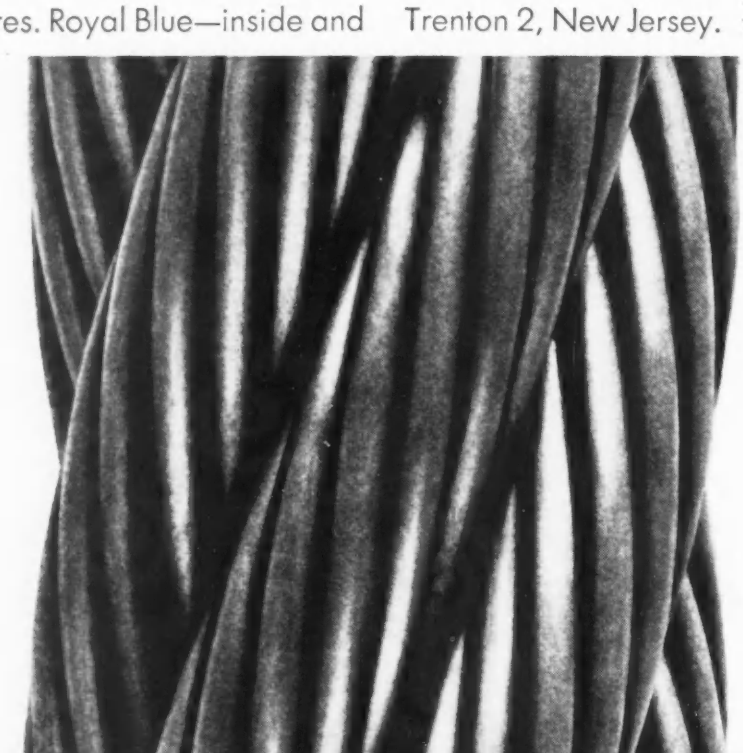

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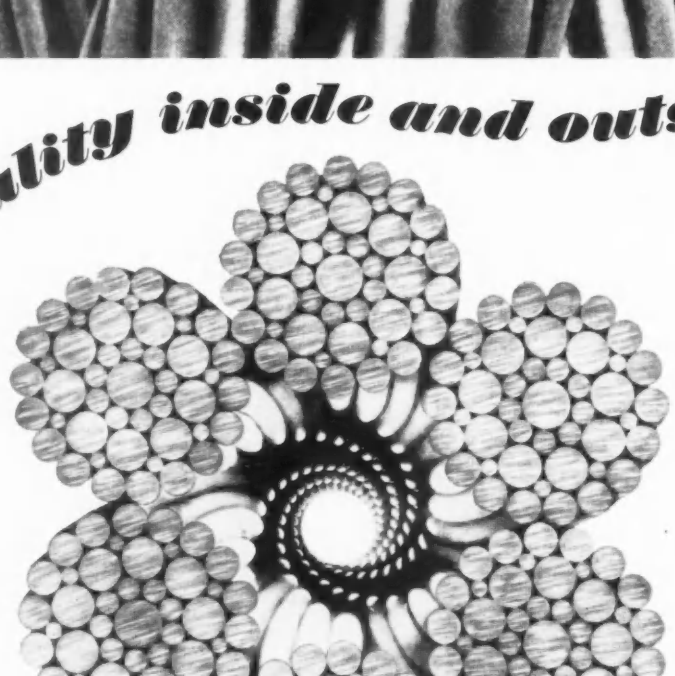

We put a lot of work into it—
You get a lot of work out of it

Looking Ahead

Can oil field equipment be purchased on annual basis—at discount rates? . . . No, says general counsel for Petroleum Equipment Suppliers Association. **Reasons:** Robinson-Patman Act prohibits price discrimination by giving discounts or other more favorable incentives to one customer than are given to other customers for same quantity and quality of goods.

Cumulative quantity discounts are not permissible because they can be allowed only on basis of an actual difference in cost which can only be done if all goods to be sold can be produced in one production run, shipped in one shipment, etc., so as to show actual saving or difference in cost through order for the larger quantity. Accumulation of a series of small individual purchases will not suffice. Also, contracts to take total requirements of given commodity from one seller may violate Section 3 of Clayton Act.

Three more California subsea completions on the way . . . Richfield Oil Corporation has requested permission to complete well in 207 feet of water, about 2 miles off Coal Oil Point in Santa Barbara County, California. Casing head would rise maximum of 12 feet above ocean floor. Completion would be four times deeper than Richfield's previous offshore California effort. (WORLD OIL, April 1961).

California Standard has made application to complete two wells about 2½ miles off Gaviota, Santa Barbara County, the first to be drilled in 235 feet of water, second would be in slightly shallower depths. If wells are successful, well head will be raised 135 feet above ocean floor, supported on cantilever mast consisting of 24 and 30-inch pipe, thus allowing divers to work longer underwater and also avoid dangerous bottom currents.

New Trend in multiple completions? . . . Southern Natural Gas Company has altered its multiple completion program in South Louisiana. Company recently completed what is believed to be first parallel dual string well utilizing casing larger than 2⅞-inch OD. Twin strings of 4½-inch casing were set in single bore hole to about 12,400 feet.

Reason for change: workover costs and formation damage in conventional dual wells have been prohibitively high. By utilizing parallel type completions, each casing string can be treated as single well, and zones can be worked over individually without exposing both productive intervals to workover fluids.

U.S. crude wells operating at less than 70 percent of capacity . . . More than 100 engineers and geologists recently completed year-long study for National Petroleum Council on U.S. productive capacity and proved reserves.

Productive capacity on January 1, 1960: crude oil, 10,585,000 barrels daily; natural gas liquids, 1,799,600 barrels daily; natural gas, 71.5 billion cubic feet daily. Crude oil capacity increased 718,000 barrels daily between January 1, 1957, and same 1960 date.

N.P.C. study and WORLD OIL statistics show U.S. crude oil wells were operating at 68.3 percent of capacity in January 1960 (10,585,000 barrels daily vs. 7,230,000 barrels daily). If capacity hadn't increased at all during 1960, operators would have been producing crude at only 67.7 percent of potential during January 1961, for U.S. crude production fell 0.9 percent to 7,162,900 barrels daily.

Good Wells Make Good News

A Report on Recent Engineered Acidizing Treatments

June, 1961

Engineered acidizing treatments by Dowell often provide outstanding results like these:

- **Andrews County, West Texas** (Old Oil Well) Pay is the Pennsylvanian from 9164 to 9176 feet. Production had declined to 10 bopd. Treatment was engineered by Dowell, with the aid of laboratory data and offset well results. Calculations were made using the "Acid Guide"*. Treatment included 10,000 gallons acid-oil-emulsion type Retarded Acid. After treatment, well leveled off at 60 bopd -- a 50 bopd increase. Offset wells treated with 10,000 gallons regular acid increased only five bopd.

- **Cameron Parish, South Louisiana** (New Gas Well) Completed in lower basal Miocene through perforations from 12,780 to 12,880 feet, production was only 200 mcfd. To stimulate production, Dowell acidized with 8000 gallons acid-oil-emulsion type Retarded Acid containing an intensifier. Freflo* surfactant in distillate preceded and followed acid. Fluid in tubing was displaced with five gallons Dowell foaming agent in distillate. After treatment, gas production was 2000 mcfd -- a 900 per cent increase.

- **Hot Springs County, Wyoming** (Old Oil Well) Production had declined to 25 bopd. Pay was the Embar lime at about 4700 feet. Well had been treated previously with 5000 gallons regular acid. Calculations with the Acid Guide indicated that Retarded Acid should be used. 4000 gallons Retarded Acid and 1000 gallons regular acid were used. Thirty days after treatment, production had stabilized at 89 bopd.

- **Hillsdale County, Michigan** (Old Oil Well) Production from this year-old well had declined to 11 bopd. Pay is the Trenton lime. Completion was open hole from 3750 to 3948 feet. Dowell acidized, using 5000 gallons Intensified Acid. Well flowed 750 barrels of oil in 22½ hours following clean-up, and production stabilized above the 125 bopd allowable for the field. Treatment cost of $1625 was paid out with the first day's flow.

Let your Dowell representative help you design your next acid treatment. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

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Let's stick to the facts

". . . THERE IS . . . every reason to believe that these majors are pushing for the day when they can control the entire fuel economy of the United States . . ."

". . . In my judgment, the independent producer as well as the consumer, is at the mercy of the ever-growing power of the integrated pipe line companies . . ."

". . . The ugly facts are that the major U. S. oil companies have enjoyed highly profitable or even record-breaking earnings, while contractors, equipment makers and service companies are on a sustained loss cycle and are ready to cash in their chips . . ."

***

These are a few of the freeswinging attacks made against large oil and gas operations during May at industry association meetings, in the newspapers and in oil publications. One of these statements was made by the president of the National Coal Policy Conference. Another by a Congressman from Massachusetts. And another by a representative of the drilling industry.

Apparently . . .

The coal man is trying to pit oil's "small business" against "big business" in an effort to win support for a National Fuels Policy study, curtailment of petroleum imports and to control the end use of natural gas.

The Congressman is trying to pit oil's "small business" against "big business" to win votes back home and support for his natural gas bill to free smaller independent producers from Federal Power Commission jurisdiction.

The drilling man is trying to pit anyone against "big business" to find a reason for what may be some of his industry's own shortcomings.

***

These widespread attacks follow a familiar pattern: when things go wrong or when support is sought for political issues affecting the petroleum industry, blame the problem on "big business."

In evaluating these attacks on "big business," it might be well to consider what would happen to this nation's economy, as well as that of the oil industry, if suddenly:

There were no farmouts made available to independents?

There were no technical advances made available to small operators—technical advances resulting from multi-million dollar research programs paid for by the major companies?

There were no more taxes for the city, county, state and federal coffers that had been so amply provided by majors?

There were no more major oil company-trained technical men to go on their own to become consultants or independent producers.

There were no more multi-million dollar budgets to purchase oil field equipment and services, to pay consultants' fees, or to buy the independent producers' oil and gas?

Seldom do these considerations appear in attacks leveled at large operators. Neither does self-examination. Neither does economic logic, in many instances. Too often, the primary aim of such attacks appears to be "win sympathy and let reason take the hindmost."

Major oil and gas operators, just as small oil and gas operators, have their faults and make their mistakes. But when these are pointed out, they should be discussed with reason, truth and accuracy. It is impossible to believe that faults described in recent weeks are as ominous as they have been made out to be.

Before making any similar attacks in the future, every segment of the petroleum industry should remember that prolonged, unreasonable criticism leveled at a major contributor to the nation's economy can eventually obstruct its operations to the extent that the entire economy is hurt, including the "small business," the Congressman and the voting consumer.

And it also is true that when factions within an industry attack each other, the climate is ideal for additional sniping at the industry from without. The petroleum industry's scars attest to that.

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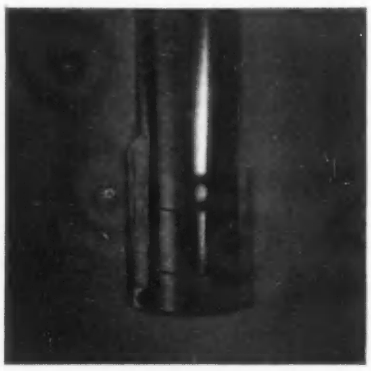

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BETTER THINGS FOR BETTER LIVING...*THROUGH CHEMISTRY*

Markets aided by supply-demand balance

By WORLD OIL Staff

THE INDUSTRY has continued in a good position with respect to inventories of oils and the balancing of new supplies with market requirements. The situation was improved somewhat in April through curtailment of refinery runs and production of products. Runs to stills averaged 7,802,000 barrels daily, down 239,000 bpd from March and off 158,000 bpd from April last year.

Stocks of all oils consequently increased only 70,000 bpd in April 1961. They had climbed 681,000 bpd in the previous month. In April of last year they increased 487,000 bpd.

Stocks. On April 30, 1961, stocks of all oils totaled 764.3 million barrels, compared with 762.2 million March 31 and only slightly above the 760.4 million held at the end of April last year. Crude stocks rose rather sharply in April, as new supplies were curtailed less than refinery runs. But the crude inventories remained substantially less than one year previously.

Gasoline stocks were reduced seasonally in April and at the end of the month were slightly lower than one year earlier, though gasoline demand is up slightly this year.

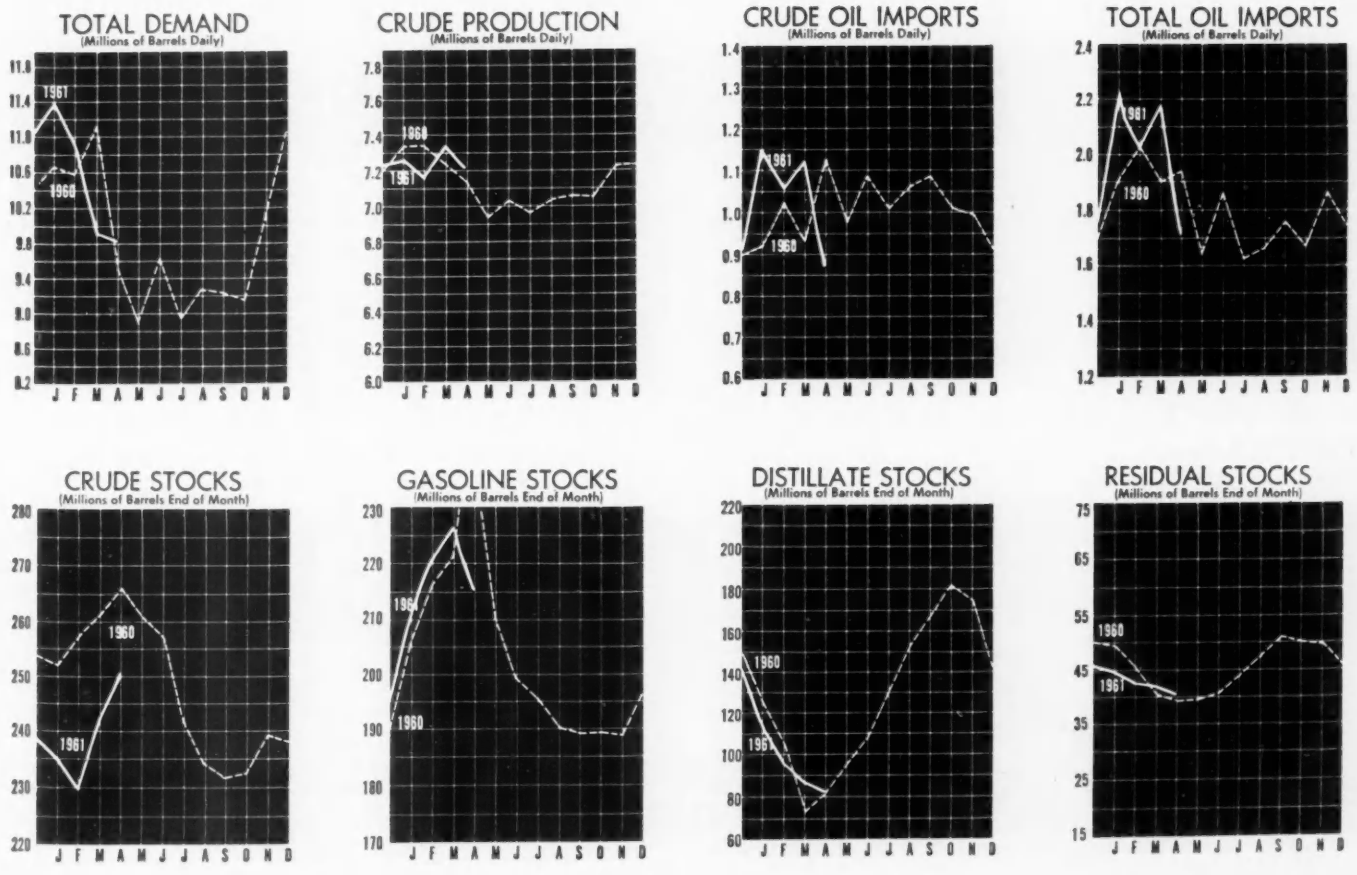
Distillate fuel oil stocks were contra-seasonally reduced in April, as cool weather bolstered demand for heating oils. Distillate stocks at end of April were only 2.6 million barrels or 3.2 percent above one year previously. Distillate demand so far this year has been slightly less than last year.

Kerosine stocks changed only a little in April and at the end of the month were 6 million barrels or 29.3 percent above a year earlier. But kerosine demand in the first four months of 1961 was 20.7 percent greater than in 1960, due to larger sales for fueling commercial jet planes.

Residual fuel oil stocks were reduced slightly in April but remained about 2 million barrels or 5.6 percent above last year's trend. Residual demand has been four percent lower in 1961 than in 1960.

Demand. Total demand for all oils in the first four months of 1961 was 7/10 of 1 percent lower than in the

Petroleum Trends...



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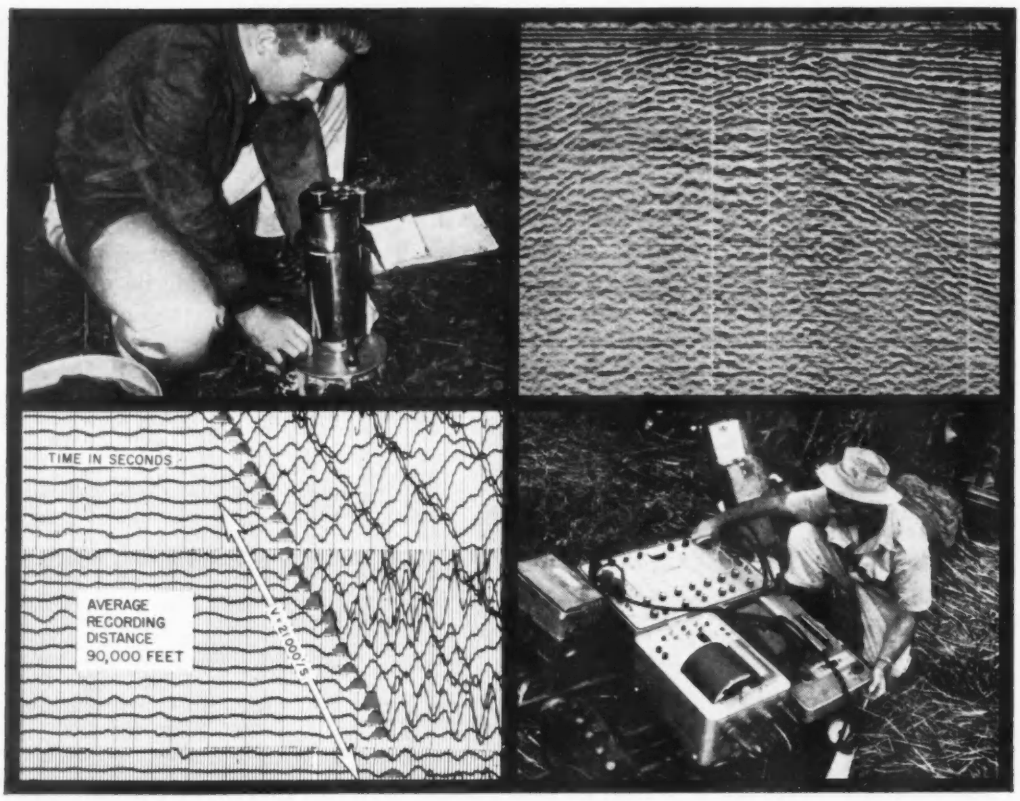

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U. S. Petroleum Demand and Supply (Thous. Bbls. Daily)

ITEM	April 1961	April 1960	% Diff.	Mar. 1961	January-April 1961	January-April 1960	% Diff.
DEMAND							
All Oils, Total Demand	9,860	9,439	+ 4.5	9,875	10,394	10,463	— 0.7
Domestic Demand	9,695	9,214	+ 5.2	9,710	10,229	10,255	— 0.3
Export Demand	165	225	—26.7	165	165	208	—20.7
Gasoline, Total Demand	4,332	4,357	— 0.6	3,909	3,940	3,921	+ 0.5
Distillate, Total Demand	1,816	1,539	+18.0	2,066	2,424	2,441	— 0.7
Kerosine, Total Demand	355	202	+75.7	389	467	387	+20.7
Residual, Total Demand	1,572	1,584	— 0.8	1,882	1,830	1,907	— 4.0
Other Oils, Total Demand	1,785	1,757	+ 1.6	1,629	1,733	1,807	— 4.1
CHANGE IN STOCKS							
All Oils, Change in Stocks	+70	+487	.....	+681	—76	—402	.....
NEW SUPPLY							
Total New Supply	9,930	9,926	.....	10,556	10,318	10,061	+ 2.6
Domestic Production, Total	8,217	7,977	+ 3.0	8,364	8,273	8,109	+ 2.0
Crude Oil	7,232	7,038	+ 2.8	7,344	7,270	7,159	+ 1.6
Natural Gas Liquids	985	939	+ 4.9	1,020	1,003	950	+ 5.6
Imports, Total	1,713	1,950	—12.2	2,192	2,045	1,952	+ 4.8
Refined Products	834	821	+ 1.6	1,070	1,015	948	+ 7.1
Crude Oil, Total	879	1,129	—22.2	1,122	1,030	1,004	+ 2.6
Crude, East of California	637	825	—22.8	809	757	756	+ 0.1
CRUDE RUNS							
Crude Runs to Stills	7,802	7,960	— 2.0	8,041	8,162	8,056	+ 1.3
Domestic Crude	6,856	7,001	— 2.1	7,033	7,145	7,089	+ 0.8
Foreign	946	959	— 1.4	1,008	1,017	967	+ 5.2

U. S. Stocks of Oils (Million Bbls. at End of Month)

KIND OF OIL	TOTAL IN U.S. April 1961	TOTAL IN U.S. April 1960	TOTAL IN U.S. % Diff.	TOTAL IN U.S. Mar. 1961	EAST OF CALIFORNIA April 1961	EAST OF CALIFORNIA April 1960	EAST OF CALIFORNIA % Diff.	EAST OF CALIFORNIA Mar. 1961
All Oils	764.3	760.4	+ 0.5	762.2	.....	.....	.....	.....
Crude Oil	251.7	266.2	— 5.5	243.2	221.1	232.4	— 4.9	211.6
Natural Gas Liquids	25.0	22.2	+12.6	23.1	.....	.....	.....	.....
Gasoline	215.2	216.1	— 0.4	226.3	191.4	184.2	+ 3.9	197.1
Distillate Fuel Oil	84.4	81.8	+ 3.2	89.5	72.6	71.0	+ 2.3	77.0
Kerosine	26.5	20.5	+29.3	26.1	24.8	19.3	+28.5	24.5
Residual Fuel	41.5	39.3	+ 5.6	42.3	27.8	25.3	+ 9.9	29.5
Other Products	120.0	114.3	+ 5.0	111.7	.....	.....	.....	.....

U. S. Crude Oil Production, by States (Thous. Bbls.)

STATE or DISTRICT	Daily Average for Month April 1961	April 1960	% Diff.	Mar. 1961	Total, January-April 1961	1960	% Diff.
Alabama	19.3	19.4	— 0.5	19.8	2,374	2,052	+ 15.7
Arkansas	79.3	79.1	+ 0.3	76.8	9,725	9,324	+ 4.3
California	827.7	834.7	— 0.8	828.3	99,306	100,484	— 1.2
Colorado	131.7	127.7	+ 3.1	132.5	15,825	15,484	+ 2.2
Florida	1.1	1.0	+ 10.0	1.0	129	136	— 5.2
Illinois	211.0	215.2	— 2.0	209.4	25,512	26,008	— 1.9
Indiana	30.6	31.9	— 4.1	31.3	3,706	3,855	— 3.9
Kansas	315.4	313.2	+ 0.7	313.1	37,673	37,325	+ 0.9
Kentucky	51.0	61.6	— 17.2	51.7	6,133	7,290	— 15.9
Louisiana	1,150.0	1,083.4	+ 6.1	1,147.7	137,688	131,140	+ 5.0
North Louisiana	109.1	124.0	— 12.0	109.1	14,376	14,931	— 3.7
South Louisiana	1,040.9	959.4	+ 8.5	1,038.6	123,312	116,209	+ 6.1
Michigan	53.0	39.0	+ 35.9	53.0	6,423	4,396	+ 46.1
Mississippi	151.5	136.6	+ 10.9	151.1	17,985	17,114	+ 5.1
Mo.-So. Dak.-Tenn.	0.7	1.2	— 41.7	0.7	105	100	+ 5.0
Montana	81.8	81.5	+ 0.4	79.7	9,841	10,008	— 1.7
Nebraska	67.8	62.0	+ 9.4	68.0	8,209	7,588	+ 8.2
Nev.-Wash.-Alaska-Ariz.	12.9	0.3	+4,200.0	10.7	1,180	89	+1,225.8
New Mexico	307.5	290.4	+ 5.9	305.3	36,487	36,285	+ 0.6
Southeast	272.8	243.6	+ 12.0	269.6	31,842	30,613	+ 4.0
Northwest	34.7	46.8	— 25.9	35.7	4,645	5,672	— 18.1
New York-Pennsylvania	20.8	23.0	— 9.6	21.1	2,433	2,657	— 8.4
North Dakota	62.1	52.9	+ 17.4	66.4	7,811	6,679	+ 16.9
Ohio	12.1	13.8	— 12.3	12.1	1,520	1,672	— 9.1
Oklahoma	544.5	530.8	+ 2.6	528.5	64,704	66,114	— 2.1
Texas	2,624.9	2,596.8	+ 1.1	2,752.2	317,936	324,952	— 2.2
Dist. 1: South Central	47.6	44.9	+ 6.0	48.2	5,625	5,353	+ 5.1
Dist. 2: Middle Gulf	118.0	117.9	+ 0.1	125.4	14,226	14,822	— 4.0
Dist. 3: Upper Gulf	351.3	348.5	+ 0.8	368.1	43,406	44,789	— 3.1
Dist. 4: Lower Gulf-S.W.	198.1	190.8	+ 3.8	205.1	23,678	23,876	— 0.8
Dist. 5: East Central	28.5	27.9	+ 2.2	29.5	3,387	3,401	— 0.4
Dist. 6: Northeast	261.1	246.5	+ 5.9	273.4	31,432	31,665	— 0.7
Dist. 7-B: North Central	130.7	122.4	+ 6.8	134.3	15,600	16,158	— 3.5
Dist. 7-C: West Central	120.2	122.9	— 2.2	126.5	14,550	15,538	— 6.4
Dist. 8: West	1,068.8	1,017.5	+ 5.0	1,136.6	130,433	130,422	.....
Dist. 9: North	194.4	193.7	+ 0.4	196.8	23,478	23,516	— 0.2
Dist. 10: Panhandle	106.2	108.2	— 1.9	108.3	12,676	13,196	— 3.9
Utah	81.6	105.9	— 23.0	90.9	11,416	13,151	— 13.2
Virginia	.....	.....	.....	.....	1	2	— 50.0
West Virginia	6.7	6.6	+ 1.5	6.8	793	721	+ 10.0
Wyoming	387.4	329.7	+ 17.5	386.2	47,504	41,609	+ 14.2
Total United States	7,232.4	7,037.7	+ 2.8	7,344.3	872,419	866,235	+ 0.7

Sources for above 3 tables: Bureau of Mines monthly reports except last two months based on API and B. of M. weekly reports and WORLD OIL estimates and Texas districts from API.

like period of 1960. Decreases for distillate fuel oil and residual fuel oil outweighed a small gain for gasoline and a good increase for kerosine.

In April the total demand was up 4.5 percent from last year. But the increase may have been caused largely by colder weather for the month, as distillate and kerosine requirements were up sharply. There were decreases of nearly one percent each for gasoline and residual demand in April.

New Supply. Total new supply in April averaged 9,930,000 barrels daily, down sharply by 626,000 bpd from March and almost the same level as in April last year. The sharp reduction of supply was seasonal in nature and well justified. It permitted needed curtailment of refinery runs and avoided unnecessary accumulations of products in storage, through crude stocks increased materially despite smaller crude production and imports.

U.S. crude oil production averaged 7,232,000 bpd in April, down 112,000 barrels from March, though nearly 200,000 bpd more than in April last year. Production of natural gas liquids averaged 985,000 bpd, down 35,000 from March but up 46,000 from April last year.

Total imports averaged 1,713,000 bpd in April, down by the large amount of 479,000 barrels from March and 237,000 bpd less than in April 1960. Crude oil imports averaged 879,000 bpd, down 243,000 from March and off 250,000 bpd from April last year. Imports of refined products at 834,000 bpd in April were down 236,000 barrels from March though up 13,000 bpd from April last year.

Markets. Industry markets in late May were holding steady and offering encouragement to those who had been worrying for several weeks about some softness of product prices. Recent reductions have applied mostly to distillate fuel oils and have been seasonal in nature. Surpluses of gasoline have been reduced, and gasoline prices have been holding up well, after having shown some weakness several weeks ago.

Prices of crude oil can be expected to remain firm if the satisfactory conditions and operations of April and May continue.

Number 6 of a Series
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1776 to SAC

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6105

Drilling improves in some areas

By WORLD OIL STAFF

U.S. DRILLING ACTIVITY in April improved over March. However, the four-month average for new well completions, footage drilled, operating rigs and wildcat activity continued well below the same 1960 period.

Well completions averaged 117 per day in April, the same as March, and 2.6 percent better than the 114 wells per day reported during April 1960.

Footage drilled averaged 500,264 feet per day in April, down 2.4 percent from the 522,073 feet per day drilled during March. However, the average was up 5.3 percent over the 475,301 feet per day reported during April 1960.

Operating rigs totaled 3,317 at April's end, up 4.4 percent over March, but down 6.3 percent from the 3,539 rigs reported operating on April 30, 1960.

Wildcat activity averaged 22 completions per day during April, up 10 percent from the 20 wells per day in March, but down 7.7 percent from the 23 wildcats per day drilled during April 1960.

With one less day to drill, new well completions were down 4 percent during the first four months from the same 1960 period—footage drilled was down 4 percent—wildcat completions were down 14.3 percent.

U.S. Drilling Activity in April and First Four Months, 1961

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED									WILDCATS COMPLETED						†Active Rigs End of Month
	April							January-April		April					Jan.-April Total	
	Oil	Dist.	Gas	Dry	Service	Total Wells	Total Footage	Total Wells	Total Footage	Oil	Dist.	Gas	Dry	Tot. Wells		
Alabama	...	....	....	2	....	2	31,085	15	165,277	....	....	....	2	2	3	5
Alaska	2	....	....	1	....	3	36,003	11	120,398	....	....	....	1	1	2	8
Arizona	...	....	....	2	....	2	2,237	5	11,348	....	....	....	1	1	3	6
Arkansas	17	....	3	23	1	44	170,529	170	636,371	....	....	....	5	5	26	32
California	87	....	11	38	3	139	555,340	543	2,300,310	....	....	2	21	23	81	131
Colorado	4	....	4	35	....	43	180,605	176	816,353	....	....	1	24	25	96	47
Illinois	58	....	1	67	....	126	268,270	538	1,165,791	....	....	....	33	33	150	223
Indiana	22	....	4	23	....	49	83,682	258	409,420	....	....	....	11	11	61	75
Kansas	147	....	40	185	22	394	1,397,285	1,515	5,421,345	2	....	2	56	60	236	220
Kentucky	56	....	21	75	2	154	115,099	748	538,746	....	....	....	7	7	18	150
Louisiana	135	10	31	103	....	279	2,092,501	1,073	8,587,766	....	....	....	33	33	132	301
North Louisiana	52	....	18	38	....	108	351,638	355	1,209,231	....	....	....	15	15	50	75
South Louisiana	83	10	13	65	....	171	1,740,863	718	7,378,535	....	....	....	18	18	82	226
* Gulf of Mexico	27	....	7	11	....	45	457,170	175	1,781,604	....	....	....	1	1	10	49
Michigan	9	....	6	29	....	44	155,036	203	686,664	1	....	....	17	18	83	93
Mississippi	15	....	5	27	....	47	470,166	157	1,606,723	....	....	....	9	9	43	49
Missouri	...	....	....	1	....	1	370	3	5,145	....	....	....	....	....	....	3
Montana	17	....	....	20	1	38	230,334	141	756,920	....	....	....	15	15	57	15
Nebraska	57	....	....	52	3	112	499,046	309	1,413,971	4	....	....	41	45	135	24
New Mexico	76	....	27	29	....	132	716,277	571	3,022,279	1	....	1	12	14	84	135
Southeast N. M.	54	....	5	20	....	79	452,706	348	1,857,184	1	....	1	10	12	72	74
Northwest N. M.	22	....	22	9	....	53	263,571	223	1,165,095	....	....	....	2	2	12	61
New York	15	....	3	3	7	28	43,925	112	175,700	....	....	....	....	....	....	25
North Dakota	10	....	....	14	....	24	150,404	70	429,417	....	....	....	7	7	15	15
Ohio	33	....	16	21	2	72	193,420	312	772,476	2	....	1	2	5	16	104
Oklahoma	188	8	31	111	30	368	1,423,640	1,567	5,974,049	2	1	....	29	32	137	521
Pennsylvania	17	....	6	14	5	42	94,092	189	526,808	....	....	1	4	5	12	70
South Dakota	....	....	....	....	....	....	.....	2	9,523	....	....	....	....	....	2	1
Tennessee	....	....	3	2	....	5	6,461	27	14,909	....	....	....	....	....	12	10
Texas	600	10	117	438	31	1,196	5,398,782	4,500	20,469,645	11	5	5	245	266	976	851
District—																
1: South Central	35	....	....	26	....	61	176,665	235	722,922	....	....	....	19	19	80	35
2: Middle Gulf	16	....	21	32	....	69	469,756	248	1,706,571	....	....	2	23	25	78	61
3: Upper Gulf	40	10	7	44	....	101	702,723	385	2,683,635	....	5	....	28	33	99	97
*Gulf of Mexico	....	....	....	2	....	2	20,910	3	29,648	....	....	....	2	2	3	3
4: Lower Gulf-S.W.	36	....	28	44	....	108	601,181	438	2,256,509	....	....	1	29	30	97	87
5: East Central	5	....	2	6	....	13	90,680	57	367,332	2	....	....	6	8	33	28
6: Northeast	46	....	3	16	....	65	333,041	246	1,283,399	....	....	....	12	12	42	56
7-B: North Central	70	....	14	87	2	173	494,857	622	1,903,390	1	....	1	43	45	194	80
7-C: West Central	22	....	3	31	....	56	251,131	221	963,252	1	....	....	20	21	82	60
8: West	171	....	6	56	18	251	1,338,499	887	4,839,606	4	....	....	34	38	143	162
9: North	111	....	6	69	11	197	469,753	760	1,975,368	2	....	....	27	29	102	117
10: Panhandle	48	....	27	27	....	102	470,496	401	1,767,661	1	....	1	4	6	26	68
Utah	18	....	2	9	....	29	162,525	76	451,867	....	....	....	5	5	28	33
Washington	...	....	....	1	....	1	4,480	8	33,488	....	....	....	1	1	6	1
West Virginia	19	....	33	12	....	64	144,652	334	838,836	....	....	....	....	....	....	128
Wyoming	26	....	2	35	1	64	369,999	285	1,553,819	1	....	....	20	21	97	36
Others	....	....	....	2	....	2	11,687	11	72,592	....	....	....	1	1	10	5
Total U.S., April 1961	1,628	28	366	1,374	108	3,504	15,007,932	13,929	58,987,956	24	6	13	602	645	2,521	3,317
March, 1961	1,789	50	424	1,256	95	3,614	16,184,263	.....	.....	46	6	26	552	630	.....	3,177
April, 1960	1,739	59	267	1,407	93	3,565	14,766,890	14,506	61,447,168	56	7	20	627	710	2,941	3,539
Western Canada: April, 1961	91	....	35	41	....	167	1,086,034	746	4,334,911	....	....	....	....	....	.....	97
March, 1961	105	....	38	67	3	213	1,288,961	.....	.....	....	....	....	....	....	.....	190
April, 1960	45	....	19	27	1	92	616,086	809	4,712,217	....	....	....	....	....	.....	134

* Gulf of Mexico wells are included in their respective district totals. † Includes wells rigging up, drilling, and temporarily shut-down.

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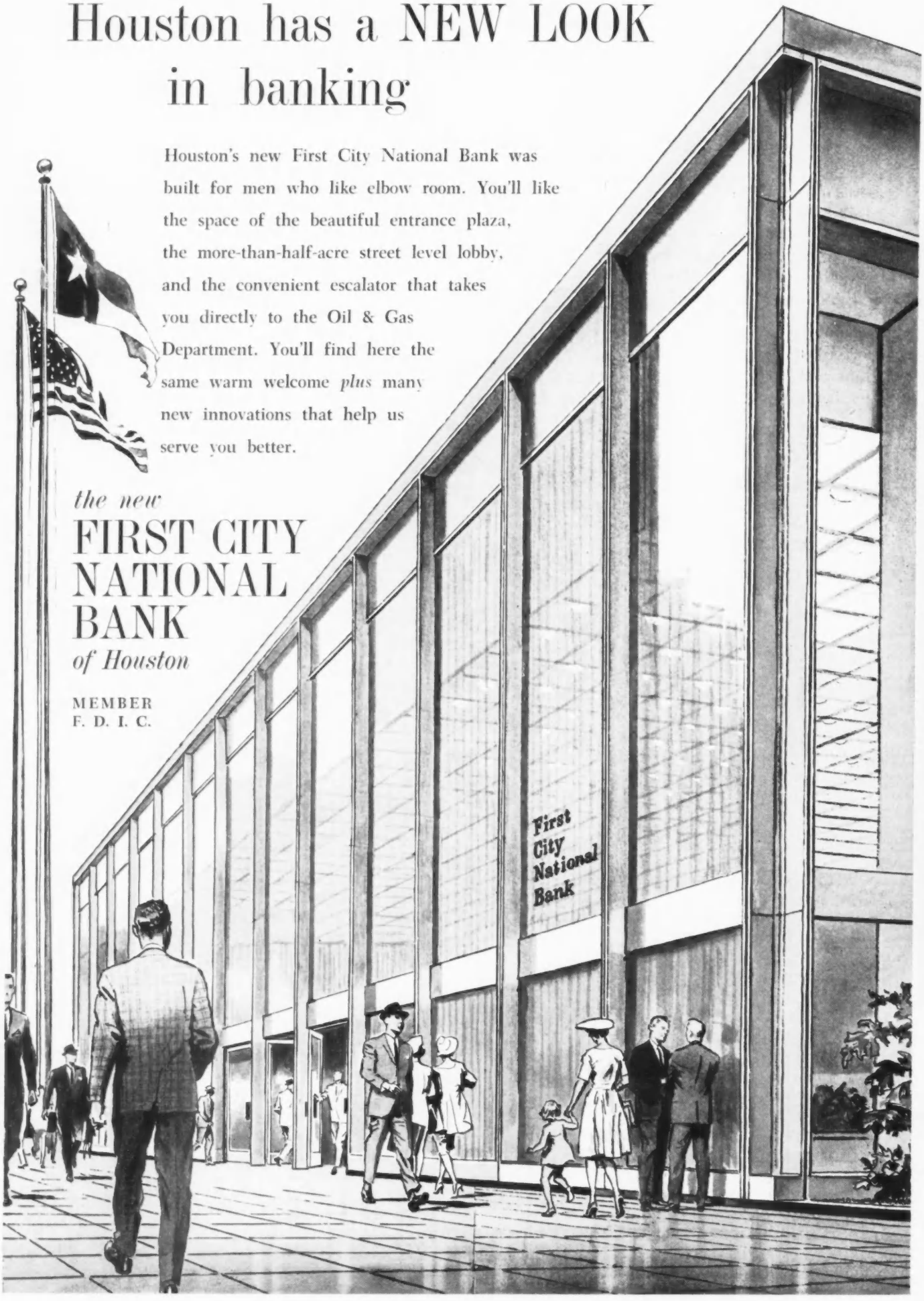

For more data on advertised products, use Readers' Service Cards, last page.

cleans the cutting surface, and a facer that end-faces, bevels and reams out the pipe. All three machines are linked into one continuous operation to produce perfect threads.

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Practical Operating Hints

These How-To-Do-It Ideas Can Save You Money

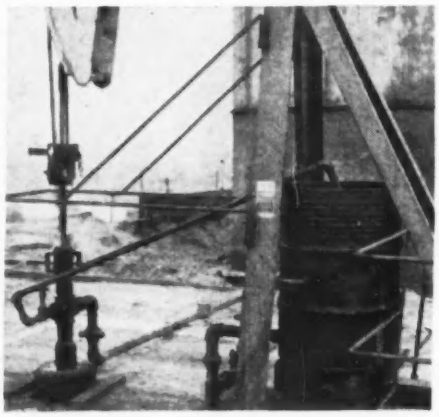
Brightly Painted Steps Reduce Accident Hazards

To reduce possible hazards to field personnel climbing tank battery ladders, one company makes a practice of painting the first two steps a brilliant orange. In sharp contrast with the usual aluminum painted surfaces of the remainder of the ladder, the bright color is a constant reminder to the pumper or gager who often is pre-occupied with writing in his gage book. Potential benefits far outweigh any slight additional cost involved in such a practice.

Get More Advantages From Elevated Multi-Light

Flood lighting can be done more efficiently and with less cost or trouble when handling the equipment by use of a multi-light rack of the type illustrated. Preferring a single rack to hold the four flood lights instead of individual smaller units scattered around the location, this contractor finds the combination unit much easier to handle and move. Individual lights on the stand can be adjusted as necessary to illuminate all parts of the rig.

The unit shown was placed some 50 feet or more beyond the end of the pipe walkway. Another advantage of the elevated rack is that it puts the lights above eye level, facilitating and reducing hazards of walking around racks and equipment at night. The light rack is equipped with bails to permit easy loading and unloading.



Gage Tank Permits Quick Well Check

An inexpensive method of making periodic checks of well production can be installed at little cost. Using the space beneath the Sampson post, a 55-gallon drum is installed on blocks laid across the pumping unit base members. A 2-inch outlet welded to the bottom of the drum is connected to the casing outlet of the well. The well flow line need not be broken as a 1-inch line is taken off from the bleeder and brought over to the top of the drum.

The pumper easily can obtain a quick gage of the well's production and, by being able to watch the total output over a period of an hour or longer (depending upon the well's gross production rate), cut, gas separation, heading action and other well characteristics also can be observed. The bleeder line extension need not be removed between gages as well samples can be obtained with the present installation. Well fluid accumulated in the drum is drained back into the well. The system also simplifies the process of mixing and injecting corrosion and scale inhibitors and other chemicals.

Venturi on Exhaust Primes Centrifugal Pump

Where it is necessary to pump water from a pit where the suction pressure is below atmospheric pressure, a novel device on the exhaust will make it easy to prime the pump.

The lever on top of the exhaust shown in the photographs is normally over to the left and allows a full flow of exhaust to the atmosphere. When the driller wants to prime the pump, he swings the lever to the right as shown and makes the exhaust go out through the venturi opening and produce a vacuum on the pump case.

Simple Drainage System Keeps Lease Looking Neat

A simple drainage system constructed of a short length of 2-inch pipe and a swage nipple keep the area around this heater treater clean at all times and reduces the fire hazard when oil is drained from the treater heat exchanger. The drain line exits in the firewall, and samples are easily caught at that point instead of directly beside the vessel.

What's the Free World offshore oil and gas outlook?

Future very bright despite huge costs. Geophysics and oceanography lead way for industry

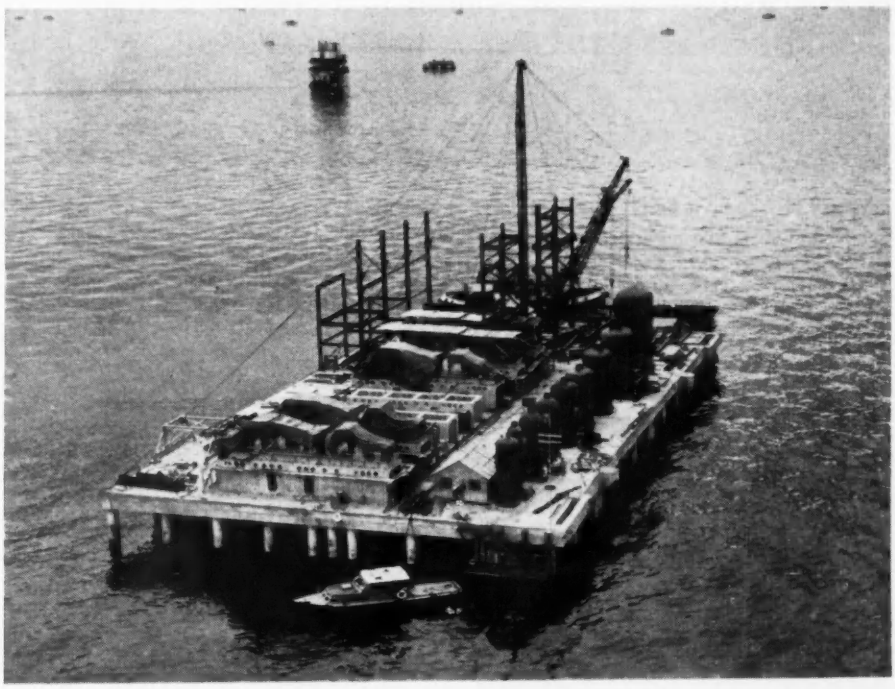


Photo Courtesy of Shell Photographic Unit, London

Compañía Shell de Venezuela has a new gas injection plant in Lake Maracaibo, shown here in the construction phase in 1960. Lake Maracaibo's offshore oil has been on production longer than that in any other offshore province, and some fields have reached the pressure maintenance-secondary recovery stage. Creole Petroleum Corp. has four gas injection plants in the Lake and is injecting virtually all of its gas produced in the Bolivar-Coastal field area back into oil-producing formations.

OFFSHORE OIL AND GAS development is becoming increasingly important, and is proceeding in a growing number of areas in the Free World. Productive trends are reaching coastlines in many nations which need more oil, and these trends are being extended into marine waters.

The oil industry now has 40 years of experience with offshore oil production which began in the early 1920s when Standard Oil Company of Venezuela (now Creole Petroleum Corporation) began to produce concessions in Lake Maracaibo. Offshore oil production in the U.S. Gulf Coast began in southern Louisiana in 1938 at Creole field in Cameron Parish, and U.S. offshore development has progressed considerably in the post World War II era. The offshore oil industry can reflect on a good backlog of experience in planning future development.

As to the future, the industry can rely on highly significant technical advances made in recent years. First, marine geophysical techniques have been improved greatly and provide greater productivity and faster coverage offshore than their counterpart operations onshore. Second, the great current surge of oceanographic research, not only on the continental shelves but also in abyssal submarine depths, continues to uncover data to help determine the nature of subsurface formations as they progress downdip from onshore into offshore areas and off the continental shelves into deep ocean waters.

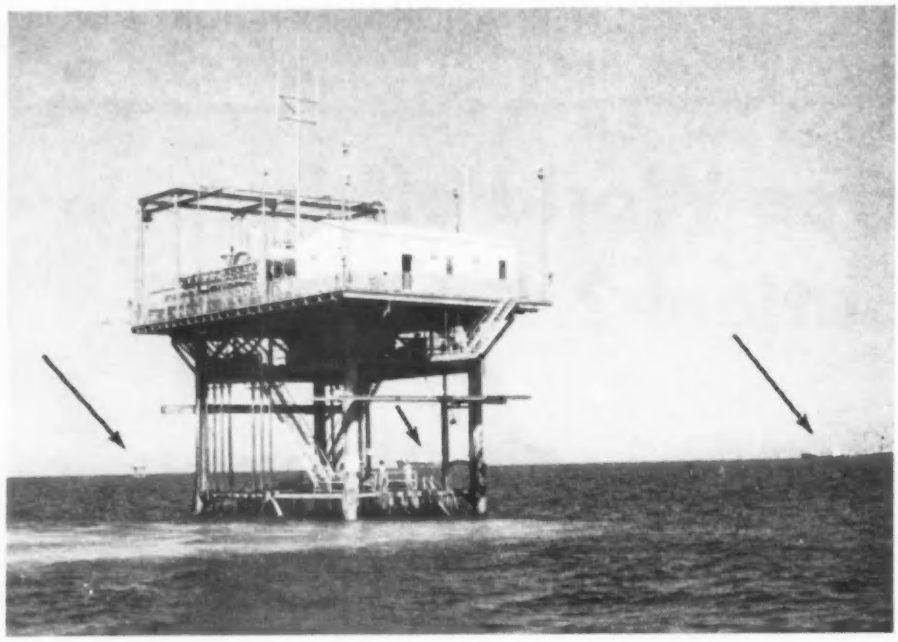
CURRENT ACTIVITY STRONG

In the U.S. Gulf Coast, drilling activity is proceeding at a more rapid pace than as of a year ago. Wells being drilled, completed, or actually permitted for drilling in offshore Louisiana amounted to 122 as of May 1, 1961, including 98 field and 24 wildcat operations. On May 1, 1960, there were only 95 well operations, including 89 field and 6 wildcat operations in offshore Louisiana.

During the first four months of 1961 there were 159 completions in offshore Louisiana, including 143 field wells and 16 wildcats. Five new discoveries, all gas, were reported during this period.

In May, 1961, six seismic crews were active in the U.S. Gulf of Mexico offshore province from Mississippi through Louisiana to south Texas.

Some recent gas discoveries in the



This photo shows a 60,000 barrels daily flow station being used as a temporary production facility by Arabian Oil Co., Ltd. offshore from the Saudi Arab-Kuwait Neutral Zone in the Persian Gulf. A well is visible behind the flow station (arrow, left). Two T-2 type tankers (arrows, center and right) are used for crude oil storage. Thirteen productive wells have already been completed in the Khafji field by AOC in one of the most significant offshore developments in recent years.

Louisiana offshore are listed as follows:

- Superior Oil Company, West Cameron Block 1
- Phillips Petroleum Company, West Cameron Block 118
- Gulf-Mobil, South Marsh Island Block 23, significant gas field on new acreage acquired in federal competitive-bid lease sale of February 24, 1960. This sale involved about 1.6 million acres of submerged land off Louisiana and Texas. Many of these new lease blocks have already had at least one well drilled on each
- Gulf-Mobil, South Marsh Island Block 48, gas discovery on a salt dome
- Mississippi Fuel, State Lease 3503, Atchafalaya Bay
- Gulf Oil Corp., Ship Shoal Block 169. Operators are drilling their sixth well. A gas discovery was also reported in Ship Shoal Block 168 (Union Producing Co. et al)
- The California Co., Breton Sound Block 49.

Activity offshore from Louisiana far overshadows that in Texas, Florida, and other states bordering the Gulf for reasons already thoroughly shown in WORLD OIL.[1] Current allowable for oil and gas condensate production in the Louisiana offshore is 280,000 barrels daily. Total cumulative production of oil and condensate in the Louisiana offshore through the end of 1960 amounted to 352,487,148 barrels, and 1,242,684,916 Mcf of marketed gas. This compares to cumulative oil and condensate production in marine offshore areas of Texas of 3,413,969 barrels, and 47,365,748 Mcf of gas sold, as of the end of 1960. Louisiana offshore oil and condensate production in 1960 amounted to 81,031,999 barrels, an average of 221,399 barrels daily. Offshore Texas oil and condensate production was reported at 629,529 barrels in 1960, an average of 1,720 bpd.

Well completions increased in the Louisiana offshore area in 1960, after a decline from the all-time high of 1957. Completions totaled 658 in 1957, dropped to 474 in 1958 and again to 466 in 1959, but climbed to 517 in 1960. At the end of last year a cumulative total of 3,425 wells had been completed in offshore Louisiana. Cumulative wildcat success ratios were 33 percent for wildcats and 76 percent for field wells. In Texas, there were 30 offshore completions in 1957, 20 in 1958, only 6 in 1959, and 9 in 1960. At the end of last year the cumulative total of completed wells offshore from Texas was 181, with success ratios being 17 percent for wildcats and 56 percent for field wells.

The current preponderance of new gas discoveries offshore from Louisiana does not appear to reflect any preferential search for gas, since Federal regulation of producers' gas prices at the wellhead, added to FPC's slowness in granting certificates for pipe line construction has hampered gas sales particularly in the case of offshore gas. Offshore operating companies generally prefer to find oil. As has been noted previously in exploration offshore from Louisiana, more gas seems to be found toward the west in the Miocene (the most prolific formation), and more oil toward the east (i.e., closer to the Mississippi River delta). This situation is analogous to the onshore Louisiana Miocene trends, some of which bear more gas than oil, others more oil than gas, and some onshore trends are being drilled preferentially for gas.[2]

Crude oil reserves are being developed in the U.S. Gulf of Mexico at a rate which make an older estimate of 13 billion barrels of recoverable oil to be found eventually in this province sound plausible. This figure was once proposed by the U.S. Geological Survey.[1]

Although detailed field data are generally held on an extremely confidential basis by companies active in the offshore U.S. Gulf of Mexico area, a comprehensive field study of South Pass Block 27 field, Plaquemines Parish, has been published recently.[3] Although only the north flank of this salt dome structure has been developed, proved reserves already exceed 200 million barrels of oil and 220 billion cubic feet of gas.

Currently the fields under most active development are South Pass Block 24; South Pass Block 27; and Bay Marchand Block 2 field, offshore from Lafourche Parish. These are oil fields.

Deeper water is continually being entered by the drilling outfits. Gulf Oil has a platform in 200 feet of water in South Timbalier Block 131 field. The CATC group was awaiting a permit in May to drill in 180 feet of water in Eugene Island Block 269.

U.S. Pacific Coast. Offshore activity is on the increase. Several important oil and gas discoveries were

made in the past year in California's Point Conception area. At least two were directionally drilled from upland locations. Interest is expanding in underwater completions in steeply-shelving ocean floor areas, where water depth is too great for platforms, and more high priced state offshore parcels have been put up for bids.

Successful bidders have paid about $71 million in bonuses for the 22,000 acres now under state lease, not including royalties paid subsequent to production.

Indicative of this interest, the outlook this year for offshore California is the completion of about 10 exploratory and 40 development wells.

Rigs now running include one each on the Standard-Humble platforms Hazel and Hilda, one of Texaco's platform Helen, one on Phillips-Pauley Harry, in addition to the two floating drill ships, Global Marine's CUSS 1 and Western Offshore Drilling's VENMAC. Also, one rig is running on the Monterey (now Humble)-Texaco island at Seal Beach.

As of May 5, a total of 19 wells had been completed on platform Hazel, 3 on the adjacent platform Hilda, 1 on Helen, and 5 on the Phillips-Pauley Harry.

Deeper water drilling is emphasized by one company's announced intention to complete, from an elevated wellhead working platform, two wells in water depths exceeding 200 feet. The first test, which was being drilled by CUSS 1, is in 235 feet of water; the second will be drilled in slightly shallower water. Use of the elevated individual well sub-sea platform brings the wellhead to within 90 feet of the ocean surface, enabling divers to work for longer periods. Also, the platform puts the wellhead above known bottom currents which are severe.

Production casing of each well will be brought up through a 30- and 24-inch cantilever mast 135 feet high, and will be topped with a working platform surrounding the wellhead. A protective mesh covering will surround well fittings.

Richfield Oil Corporation plans another ocean floor completion below 200 feet of water near its Rincon Island operations. Richfield's initial ocean floor completion in California —the state's first—was in 55 feet of water.

Signal Oil and Gas Company has announced plans to build a $2 million drilling platform about 1½ miles off Huntington Beach. Designed to accommodate about 30 producing wells, the two-level steel platform will stand in 40 feet of water.

Additionally, geophysical work is under way in a tidal flats (delta) area off northern California, near Crescent City. In Oregon, new state regulations governing offshore exploratory operations are expected to arouse increased interest in offshore exploration. And in Washington, various operators continue to hold offshore acreage.

Offshore work in Canada has been relatively minor, but interesting experience has been acquired with gas production in Lake Erie and Lake St. Clair. These lakes are heavily frozen during the winter months. A total of 104 offshore wells had been drilled in eastern Canada as of the end of 1960.[2] Most of this work had been done with cable tool rigs, although some rotary drilling has been done in Lake St. Clair.[4] El Paso Natural Gas Products Co. is expected to try to use rotary tools in Lake Erie this summer.[2]

By far, most Canadian offshore activity has been in inland lakes, although there is some interest in marine offshore possibilities off Nova Scotia in the Atlantic, and off the West Coast and in the Arctic Ocean also.

Offshore oil in Mexico has recently been highlighted by announcement of acquisition by Continental Oil Company of half interest in the venture held by Pauley Petroleum, Inc., to develop Santa Anna field in the Bay of Campeche. As of mid-March 1961, the field had eight wells producing more than 5,300 bopd from the Miocene at about 10,000 feet. The field is located on a partially developed and highly faulted salt dome. Four wells had been completed from a potential 12-well platform from which drilling was to be continued.

Trinidad's offshore oil activity has been a bright spot in the island's industry since discovery of Soldado oil field in the Gulf of Paria near the Venezuelan line. Development is proceeding from two fixed platforms. One mobile platform has been used in the Trinidad portion of the Gulf of Paria and another is expected to be added this summer. About 2 million acres have been leased to oil companies in Trinidad's portion of the Gulf of Paria.[5] Now that offshore areas on the eastern side of Trinidad have been opened to the oil industry, the island appears to have an even brighter future as to offshore drilling than before.

In Venezuelan Gulf of Paria waters, development has not been so encouraging. Discovery of the Posa oil field early in 1958 was followed by seven additional producers drilled directionally from a platform at the discovery site. Since yields from these wells have been disappointing, development has been suspended. Eleven wildcats in other parts of the 152,000-acre block have been dry.

Lake Maracaibo in western Venezuela was the first offshore area to be extensively drilled. Vast reserves continue to be proved there, despite the current slowdown in the Venezuelan oil industry. More than half of Venezuela's 17 billion barrels of crude oil reserves is located in the Lake Maracaibo area.

About a year ago Gulf Oil Corp. announced completion by Mene Grande Oil Co. of three widely spaced wells in the south Ceuta area of Lake Maracaibo as highly prolific oil producers, with individual pay thicknesses of each totaling up to 1,000 feet. It was said that this could be the largest field found by Gulf companies since the original Kuwait discovery.[6]

Venezuelan Sun Oil Company continues to complete big wells in its block in Lake Maracaibo. Some wells along the Lama field trend have more than 1,000 feet of effective oil pay.

Lake Maracaibo has served as a proving ground for many offshore developments, including use of aluminum drilling rigs and other anti-corrosion methods and materials.

West Coast of South America. Submarine drilling in Peru began in the mid-1950's when Douglas Oil Company drilled several productive oil wells directionally from the Pacific shore. The world's first underwater completion was made last year by Peruvian Pacific Petroleum Co., a Cities Service subsidiary.

Offshore drilling in Magellan Strait. Chile's Empresa Nacional del

Teikoku Oil Co. Katamachi 1 was spudded in January 15, 1961, in the Sea of Japan off the northwest coast of the main Japanese island, Honshu. Winds exceeding 80 mph were often encountered last winter. Eight wells are scheduled from this platform to develop the offshore extension of what is expected to be one of the biggest gas fields in Japan.

Petroleo (ENAP) has developed commercial oil production on both Tierra del Fuego Island and on the mainland north of the Strait of Magellan. The first fields developed on the mainland were Faro, Faro Este, Punta Delgada, and Punta Delgada Este.

Within the past year important mainland discoveries have extended the Spring Hill (Cretaceous) sand trend farther eastward into a narrow border strip which extends almost to the Atlantic Ocean.

Daniel oil field appears to be the most important discovery on the mainland to date. As of April 1, 1961, nineteen wells (all vertical holes) had been completed at Daniel, including 16 oil well and 3 dry holes. It appeared likely that Daniel will eventually have about 100 wells, including 20 onshore and about 80 *offshore* in the Strait. There is a shoal from which about twenty wells might be drilled directionally from a platform. However, development of much of the offshore portion of Daniel field will be a difficult problem because of severe weather for which the Tierra del Fuego area is well known. There is a nine-knot tidal current in the Strait of Magellan which each day flows alternately northeastward toward the Atlantic and southeastward toward the Pacific.

East Coast of South America. Some rather cursory offshore drilling has been done in the Comodoro Rivadavia area by Yacimientos Petroliferos Fiscales (YPF). This effort has been limited by lack of funds and the need to develop onshore reserves. In Brazil, Petrobras has 25 offshore oil wells near Salvador in the Reconcavo (Bahia) Basin.

Western Europe. Some offshore drilling has been done by AGIP Mineraria to extend Gela oil field southward from the Sicilian coast into the Mediterranean. Offshore drilling is expected in the Adriatic Sea east of the Italian shore, in the North Sea off The Netherlands and West Germany, and eventually in the English Channel between the United Kingdom and France.[8] Also, recent surveys of islands in southwestern Greece point to some future offshore drilling there.

Africa. Although marine geophysical surveys are or have been under way in Libya, Spanish Sahara, Senegal, Nigeria, Gabon, and a few other areas on the Atlantic Coast of Africa, offshore drilling has been restricted to a few wells in the Gulf of Suez and in some lagoons in Nigeria.

Mobil International Oil Co. was slated to commence a 16-month drilling program in Gabon in August, 1961, following an offshore seismic survey which indicated a number of favorable structures. A mobile jack-up type platform, to operate in up to 100 feet of water, was to be used.

Persian Gulf has vast offshore oil reserves. Commercial oil fields in the Persian Gulf include Safaniya and Manifa in Saudi Arabia and Khafji in the Saudi Arab-Kuwait Neutral Zone.[8] Umm Shaif field offshore from Abu Dhabi and east of Qatar is also considered commercial since pipe line connections are being made. Shell of Qatar has found oil within the past year at Idd El Shargi, 52 miles offshore from Qatar's east coast, in the Shibeeb formation (middle Jurassic). In Iran, Societe Irano-Italienne des Petroles (SIRIP) has completed an oil well good for about 3,600 bpd about eight miles offshore in the upper Persian Gulf near Ras al Barghan.

Safaniya-Khafji all one field? At the time Safaniya field in Saudi Arabia was placed on production,[9] it was already the largest oil field in the world in offshore *marine* waters (Lake Maracaibo water is fresh to slightly brackish). At that time Safaniya, which has two onshore wells, had already been shown to extend more than ten miles offshore, and more than 70,000 surface acres had been proven. Since then Khafji field has been discovered in the Neutral Zone by Arabian Oil Company, Ltd. (Japanese interests), and 13 wells have been completed to date at Khafji on the same structure, with no dry holes.

Reports persist that Arabian American Oil Co.'s Safaniya wells have been climbing progressively higher on structure as they have been drilled northward toward the Neutral Zone. This subject is touchy since a border area is involved. Since Aramco's drilling vessel Queen Mary sank in a storm early in 1961, it has been refloated and relegated to offshore workover work. A new drilling outfit is on its way. The new one is designed to operate in deeper water than the Queen Mary, hence Safaniya is apparently to continue to be drilled farther offshore.

Safaniya crude is described as being 27 API gravity; Khafji is 26.8°. Other characteristics of the crudes are similar. Both fields produce from Cretaceous *sandstones* between 5,100 and 5,600 feet of depth. A possible mammoth oil field, at least 60 miles long and from 10 to 15 miles wide, can be envisioned here. Obviously, the Persian Gulf's offshore potential has only begun to be evaluated.

Japan, needing more oil from domestic sources, has successfully developed some offshore reserves off the northwest coast of the main island (Honshu) on the mobile rim of the Japan Sea, in treacherous waters. Large anticlinal folds offshore may prove more prolific than oil and gas fields found thus far onshore in Japan.[10]

Teikoku Oil Co. spudded Katamachi 1 on January 15, 1961, on a

platform intended to develop offshore reserves of this gas field which is considered to be the biggest in Japan. Winds of up to 80 mph are experienced in this location during the winter.

FUTURE OF OFFSHORE DEVELOPMENT

Despite tremendous costs of offshore production, offshore oil and gas operations have a bright and vigorous future. Efficient means developed to provide geophysical coverage make it relatively easy to find structures offshore, and as techniques of interpreting stratigraphy via geophysical interpretation are developed onshore, they can be applied offshore as more well control becomes available in new areas. Augmenting and tying in with increasing geophysical control offshore are the rapid discoveries being made in the field of oceanography, emphasized in this issue of WORLD OIL in the article on the "Mohole" (See Page 84).

Reconnaissance geophysical coverage of the continental shelves will be completed rapidly. Such regional marine seismic work in the U.S. Gulf coast was virtually complete several years ago[1]. Most current work is to detail structures found during the reconnaissance phase. At present, rapid coverage of the Atlantic coast continental shelf of Africa is underway.

Productivity of marine seismic work has always been high, and is increasing. Important breakthroughs have been made in recent years. A seismic crew can operate from 2 boats or from only 1 boat. Gas exploders have been used instead of conventional explosives, and multiple-explosion techniques have been developed to provide a type of offshore pattern shooting. The electrical profiling or "sparker" technique[11] provides good records down to about 1,000 feet and now is being used in combination with the gas exploder. Shallow "sparker" data often correct, on comparison, the normal problem of ragged near-surface seismic records.

A striking example of the extreme productivity of offshore seismic is shown by preliminary Society of Exploration Geophysicists figures on activity in 1960. Only 31.4 party months of marine seismograph work was tabulated for Africa last year, compared to 165 party months of conventional seismic work onshore. This marine offshore work included 1.0 month in Cabinda, 4.3 in Gabon, 2.0 in Libya, 0.5 in Morocco, 5.3 in Nigeria, 1.0 in Portuguese Guinea, 9.3 in Senegal, 2.0 in Somalia, 3.0 in Spanish Guinea, 2.0 in Spanish Sahara, and 1.0 in Sudan. However, in Nigeria, an *equal area* was covered by a marine seismic crew in one month as had been worked in 24 party-months in mangrove swamp and jungle areas onshore.

In another breakthrough, a seismic crew, using specially-adapted jet-driven small boats, was able to operate in as little as three inches of water (or even in three inches of soft muck, since either could be jetted). Good records were acquired. The crew was able to bridge a chronic gap in coverage between onshore seismic and deeper water marine work. Seismic work in mud flats may be much easier and more effective in the future.

The determination of indigenous Pleistocene production, subject of an article in this issue of WORLD OIL (See Page 122), opens an enormous worldwide offshore area for oil and gas exploration. Many drowned river deltas may become exploration targets. Coarse Pleistocene sands will be found farther out on the continental shelves than those being deposited today, since sea level was lower during much of Pleistocene time. In at least one case in the Gulf of Mexico, coarse Pleistocene sediments have been found during oceanographic research in deep waters off the continental shelf.[12]

Many new offshore areas. New marine areas expected to become oil and gas provinces in the future include:

- The U.S. Atlantic Coast is now being explored. Seismic work has been done by Kerr-McGee Oil Industries, Inc., off New Jersey and by Pure Oil Company off Georgia. Kerr-McGee reported rapid, smooth coverage and acceptable records. On the New Jersey coastal plain, excellent Cretaceous-lower Tertiary sandstones outcrop, and shale breaks should develop between them downdip in the offshore. Basement highs south of Nova Scotia, and south of Cape Cod and Long Island have been mapped from research seismic work.[13] Farther south, sizable stratigraphic trap accumulations may occur along both flanks of the Carolina ridge (or Cape Fear arch) in its seaward extension from the Carolinas.

- Cook Inlet in Alaska may prove both prospective and drillable. A seismic survey has been conducted recently offshore, primarily to indicate the less accessible adjacent onshore trends.

- Argentina is expected to record more offshore activity in future years since the South Atlantic continental shelf covers a large area there.

- In Iran, in addition to prospects in the Persian Gulf, oil may be found in the future south of Russian production in the Caspian Sea. Surface level in the Caspian is dropping, possibly because of upstream diversion of Volga River water by the Soviets.

- Vast marine areas offshore from Borneo, where some wildcatting is being done, in Indonesia, the Philippines, Australia and New Guinea are considered to be prospective and await more tangible future developments.

ACKNOWLEDGMENT

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Project Mohole demonstrates deep water drilling techniques

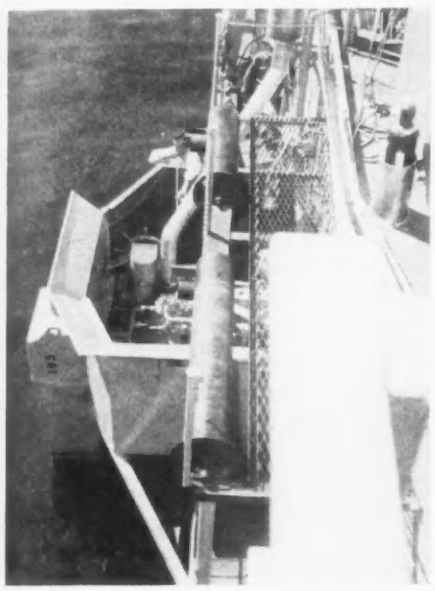
Aerial view of CUSS I as she maneuvers, with outboard motors, to move into position preparatory to starting drilling at the new site. Note outboards at each quarter of the vessel. Man is standing on 13,500 feet of drill pipe carried on pipe racks aft of derrick. Pilot house, from which all controlling of outboards is done while on location, is forward of bridge, lower right corner of photo. Extra drill pipe, casing, guide shoes and other equipment are carried in racks between derrick floor and bridge.

By Gilbert M. Wilson
West Coast District Editor
World Oil

Using outboard motors to hold position in open ocean, CUSS I drills, cores Miocene sediments, basalt in 11,700 feet of water

Project Mohole, Phase I of which was just concluded 90 miles off the coast of Baja, Calif., proved to many in the oil industry and more specifically those close to floating vessel drilling techniques, something they already suspected: that depth of water need not be a barrier to oil exploration.

This significant point was proved in open ocean about 220 miles south and west of San Diego, an ideal area to test men, equipment and techniques. The water was 11,700 feet deep. Sea swells ranged anywhere from 6 to 14 feet, and blustery winds often reached velocities of 35 to 40 miles per hour.



One of the outboard engines on the CUSS I. View, taken before cover and snorkel were installed prior to going out to the deep water site, shows engine, right angle drive and the control wheel, the latter to be manned individually should the centralized master controls at pilot house fail while vessel is on station.

Holding position within only 200 to 300 feet of a point directly over the hole, using four outboard engines in the constant maneuvering necessary to stay in the center of a ring of special buoys, the drilling vessel CUSS I successfully drilled six holes, the deepest 601 feet, in the ocean floor. This operation followed by only a few days the equally successful shakedown in the San Diego Trough, in 3,140 feet of water, when five holes were drilled and cored, the deepest one reaching a total depth of 1,043 feet.

CUSS I is a converted sea-going Navy barge owned by Continental Oil Company, Union Oil Company of California, Superior Oil Company, and Shell Oil Company.

It was re-designed and rebuilt to drill in deep water. Since the commissioning in 1956, it has drilled more than 200,000 feet of hole. Although the vessel has operated in relatively shallow waters, varying in depth to a maximum of 400 feet, permitting it to be anchored during drilling operations, the fact that it successfully performed the Mohole work as a maneuverable floating barge attests to the basic design. Prior to the Mohole assignment, the 260-foot, 48-foot beam, 3000-ton CUSS I in recent years has successfully withstood up to 60-knot winds and long-period 12-foot swells.

Operation Mohole and its planning demanded—and got—some of the best ideas and operating talent available. From the oil industry as well as from universities, research groups and service and supply companies, were drawn personnel and ideas to design and build special pieces of equipment and to devise techniques needed to adapt CUSS I to the conditions and water depth anticipated in the tests near Guadalupe Island.

Until Phase II of the Mohole project is undertaken, a very deep test, the present operations will become history and the near-fantastic records established in open ocean will be studied by earth scientists, engineers and the oil industry.

Except for the remarkable system of outboard motors and electronic gear by which CUSS I was held on station, almost all drilling equipment and the techniques involved were those which had been employed in the oil industry for years. One exception was the specially-designed guide shoe, a special adaptation for deep water drilling.

Bending stresses reduced. Early in the planning of Operation Mohole it was known that special engineering would be necessary to design and predict the behavior of the 4½-inch drill string that would hang, unrestricted by casing, beneath the vessel. Studies of Arthur Lubinski, research associate for Pan American Petroleum Corp.,

World Oil staffer "on-the-scene" to cover first deep water probe

West Coast Editor Gilbert Wilson spent several days aboard CUSS I to provide World Oil readers with a first-hand report on the Mohole test near the Guadalupe Islands. His objective was to prepare a report that would describe in detail the technical aspects of the project—and place the oil industry's contribution in its proper perspective. He succeeded on both counts, as you will read on these pages.

Funnel-shaped steel rib-reinforced guide was designed to prevent sharp bending of drill pipe beneath the vessel

Tulsa, in considering pipe fatigue, bending stresses, transverse vibration, the possibility of destructive resonance and the bending action by subsurface currents, resulted in the designing of special guide shoes to minimize localized stress at two critical points: beneath the vessel and at the top of the hole at the ocean floor.

Designed by the American Miscellaneous Society committee staff, the shoe beneath the vessel was a 35-foot long funnel-shaped, steel rib-reinforced guide built in two sections and assembled in rigid supports beneath the rotary table. The small end was hung from a point about six feet below the table. The guide, 58 inches in diameter at its lower end, projected below the vessel. Its curvature was so designed as to prevent sharp bending of drill pipe that would occur when the ship rolled.

Another critical point at which bending stresses would tend to occur was immediately above the hole, on the sea floor. For this point, a "tapered casing" guide section, 40 feet long and attached to the landing base, provided flexible support. The guide casing had walls that were machine tapered so that, with the thinnest section on top, maximum flexibility combined with strength would be provided. Beneath the base, and so designed as to be run in at the time the base was landed, was hung a string of several hundred feet of casing. The latter was equipped with a casing cutter shoe to prevent sloughing of unconsolidated sediments at the sea floor.

As it turned out, the bottom landing base and shoe were used on only one of the holes, and this one was at the La Jolla shakedown test site. Bottom sediments at the Guadalupe site were sufficiently firm that little hole problems were encountered. Coupled to this was the fact that so perfectly did the outboard motor maneuvering system work in holding the vessel on station that it did not drift more than the estimated several hundred feet in any direction away from the center of the hole.

Outboards maneuver vessel. The four outboard motors provided a unique and efficient method of controlling and limiting drift of the vessel. Positioned at the four quarters of the ship, and powered by 200-horsepower diesel engines, the system was designed to provide instant control in both direction and amount of thrust by moving a short "joy stick" lever mounted on a console in the pilot house. As a safety measure, each of the outboards could be manned and controlled by telephone from the pilot house should anything go wrong in the centralized control system.

A 24-hour watch was maintained by pilots and assistants in the darkened pilot house located just forward of the bridge. Three kinds of information constantly were fed to the pilot, sonar, radar and analog inclinometer data.

For the sonar control, a ring of six taut-line buoys of special design and shape was anchored to the bottom so the buoys would be held at a point 200 feet below the surface of the water. They were positioned about

For a Quick Picture of Project Mohole

- ***What it is . . . .***
  An experimental deep sea drilling program designed to test floating vessel equipment and techniques to be used later—perhaps several years hence—in drilling the ultimate Project Mohole. The final phase of the project, site for which still has not yet been determined, will be an attempt to drill through the earth's crust to reach and sample the mantle, the material which comprises 84 percent of the earth's volume. The boundary between the crust and the mantle, known as the Mohorovicic Discontinuity (Moho for short), may be reached in the ultimate Mohole by drilling in water as much as 18,000 feet deep and into a thickness of crustal rock amounting to perhaps 15,000 feet.
- ***Who is sponsoring it . . . .***
  It is part of a long range scientific project being carried out by the National Academy of Sciences—National Research Council, a private organization of scientists, through its AMSOC Committee. The support is by the National Science Foundation, an independent agency of the federal government.
- ***Who did the drilling on this phase of the project . . .***
  Global Marine Exploration Company, Los Angeles, under a $735,800 National Science Foundation contract, was the contractor. Its CUSS I, a floating drilling vessel, was specially outfitted with outboard engines and other special gear needed for drilling in 11,700 feet of water.
- ***What was accomplished . . . .***
  In shakedown operations in 3,140 feet of water off La Jolla, near San Diego, drilling and coring was done in five exploratory holes, the deepest being 1,043 feet. In 11,700-foot water tests in open ocean between Guadalupe Island and the Baja California coast, six holes were drilled, the deepest being 601 feet. Miocene sediments were cored almost immediately in the ocean floor, with hard basalt being encountered from about 560 feet to total depth reached at that site.

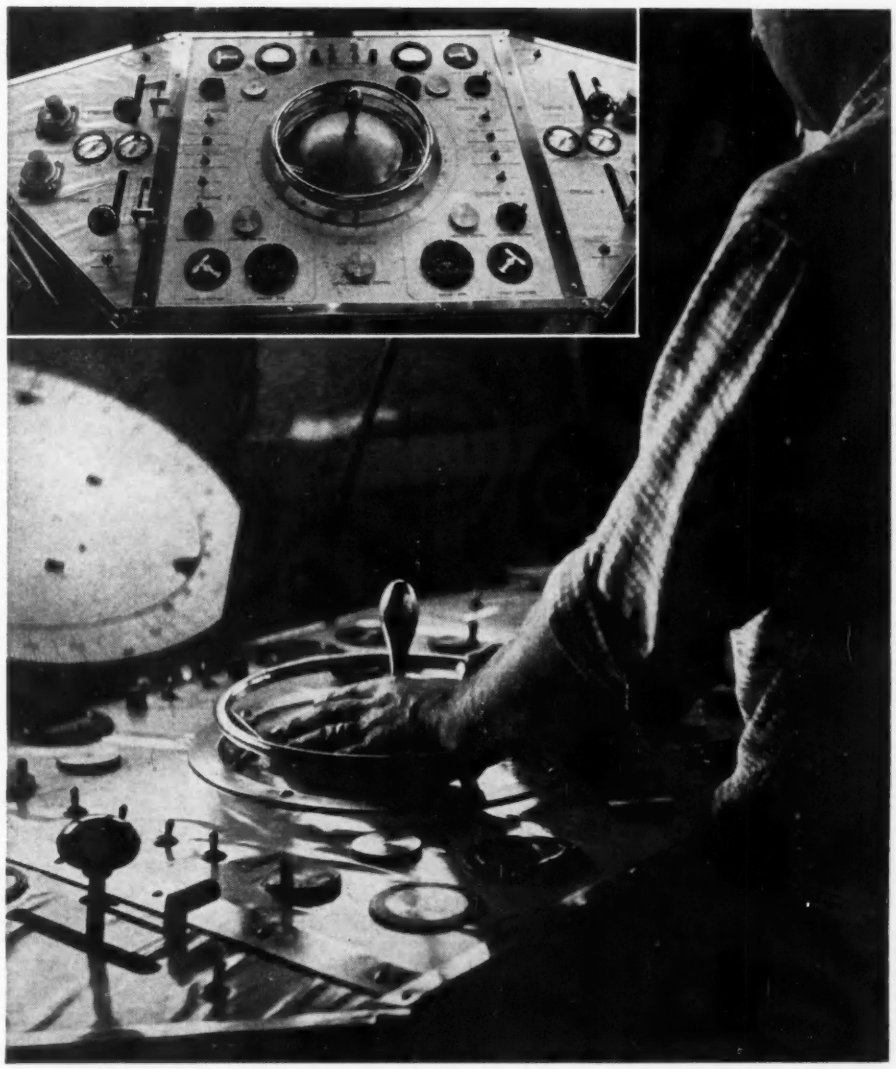
1,000 to 1,200 feet from the ship and from each other. Attached to the buoys were sonar transponders which, on receiving the ship's sonar ping, returned it on another frequency, the time involved in the trip providing an exact distance between the ship and the buoy.

Radar reflectors attached to spar buoys at the surface provided a second position check using the ship's radar, the latter specially modified for use on such short ranges. Certain of the buoys also carried flags and flashers for visual checks.

The third check on the ship's position in relation to the vertical projection of the hole was the analog inclinometer, a coaxial cable held in constant tension between the ship and an anchor on the ocean floor. The cable is designed to be an analog of the drill pipe and the instrument on the bottom of the sea floor will, by its inclination, represent a bending of the drill pipe where it enters the hole. Information from the inclinometer is fed to the pilot house by an X-Y coordinate recorder, serving as an additional guide to the pilot in maneuvering the ship.

Although normally equipped to carry 8,500 feet of drill pipe for routine drilling, CUSS I carried 13,500 feet of 4½-inch drill pipe and drill collars for the Mohole job. Three different weights of pipe, all Range 2, were included in the string: The top 1,500 feet was 20 pounds per foot, vanadium alloy heat treated, 105,000 psi minimum yield pipe; the middle section was 3,500 feet of 16.60 pounds per foot vanadium alloy heat treated, 110,000 psi yield (ultimate 135,000) pipe; and the lower section was 8,000 feet of 13.75 pounds per foot Grade E, 75,000 psi yield (110,000 ultimate) drill pipe.

Bumper subs in string. The drill collar string, the bottom 500 feet, consisted of 7½-inch OD by 3½-inch ID, 30-foot joints weighing 4,500 pounds. Included with the collars were four bumper subs having a stroke of five feet each. The kelly was 40 feet long, round fluted and with a 6⅝-inch OD.



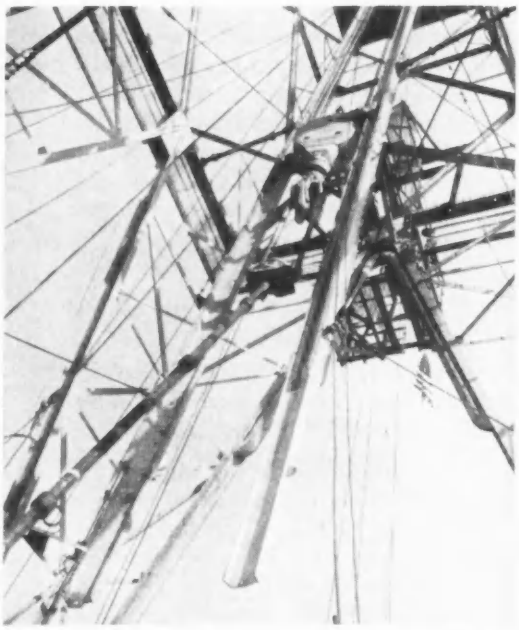
Pilot, operating specially-designed console and "joy stick" control, maneuvers CUSS I and holds her on station over hole with outboard engines mounted at each quarter of the drilling vessel. Sonar, radar and other information fed to the pilot, enables him to hold position in center of ring of special buoys surrounding site. Offset shows detail design of console controls.

An automatic double elevator system was used for these operations. The traveling block, with eight lines strung, was equipped with ears and roller guides which ran inside structural steel guides extending down from the crown. This traveling block guide and the automatic pipe racking system (see photos) were specially designed for sway and whip loads in rough weather and were part of the original equipment built into the CUSS. Total hook load ranged from 200,000 to 250,000 pounds.

Wire line core barrel. For the Mohole tests, no surface casing or guide system was contemplated so, once the bit was pulled from the hole, it would be unlikely, if not improbable, that the bit could re-enter it. All coring, therefore, had to be done with a wire line core barrel and all instruments, heat probe, electric log and gamma log sondes had to be run

Drilling proved to be conventional and routine except that no returns were obtained at the surface

Pulled and racked in doubles, drill pipe is run out on the retrievable skate, the latter visible at center, right, as it nears the end of its normal "run". The skate is used, similarly, when pipe is pulled in from the rack.



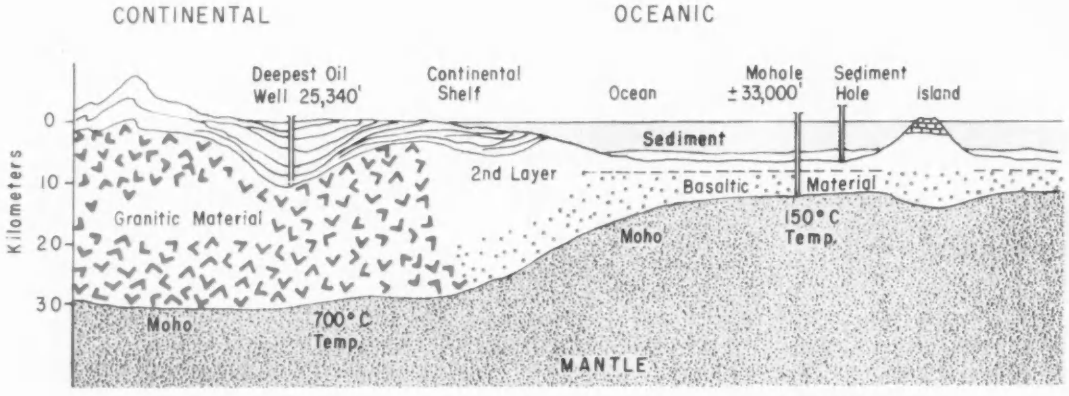
Another single is pulled in as hole is being made at the site off Guadalupe Island. Traveling block moves in guides to prevent excessive swaying as vessel rolls.

through the opening in the bit.

Another problem was that of designing the bit so it would be suitable for both soft, unconsolidated formations and deeper, more consolidated formations. As it developed in the Guadalupe tests, the bit used was called upon to drill and cut cores in hard volcanic basalt.

The 9-inch diamond bit selected was designed around a 6¾-inch OD outer assembly which would receive several combinations of inner assemblies. For straight drilling, a center bit was dropped. When coring was to be done, the center bit was retrieved with the ½-inch sand line and a core barrel dropped. For soft sediments, a hydraulic punch type barrel was capable of taking 2-inch cores up to 10 feet long. For harder formations, a swivel type inner barrel with basket core catcher, or a split ring catcher, could take $2\frac{7}{16}$-inch cores.

Pump pressure watched. Sea water was used for circulating except in isolated instances when mud was spotted in the hole when a core was taken or when, as in one case, the hole became sticky. Except for the fact that there were no returns, drilling proved to be more or less conventional and routine. Initially, it was difficult to tell exactly when the bit was on bottom or when the bit had drilled off.



Cross-sectional diagram of the crust of the earth at the site of the Mohole project.

It soon was found, though, that the best way of determining this was in keeping a close watch on pump pressure; an increase indicating that the bit was on bottom. Although it varied considerably, pump pressures while drilling ranged from around 100 to 500 psi and, occasionally, as when in basalt, as high as 700 psi. Typically, also, about 5,000 pounds was carried on the bit. Rotary speeds averaged around 20 to 25 rpm, but occasionally reached 30 rpm.

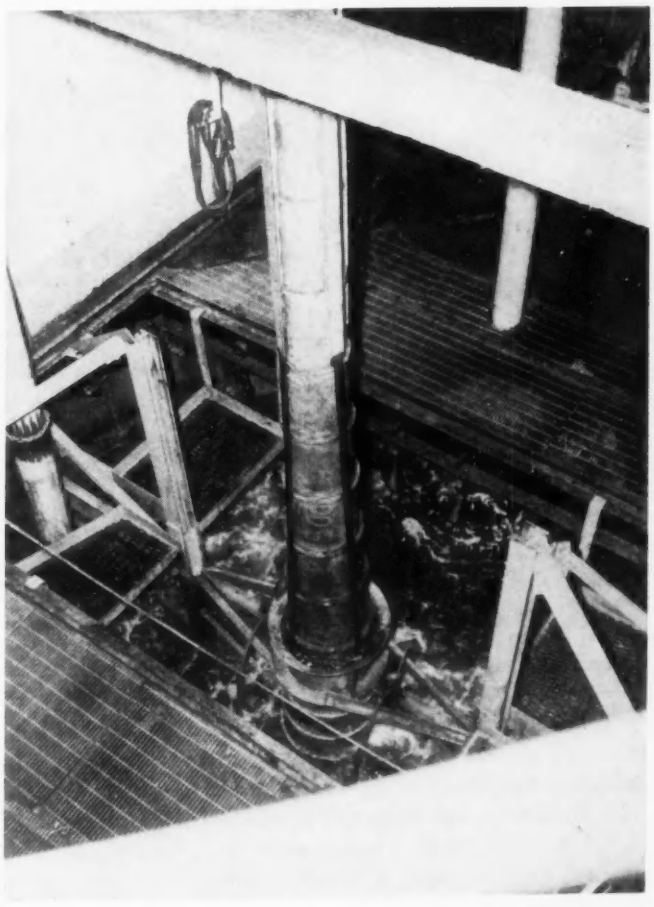
The drawworks was grooved for 1¼-inch wire rope and was driven by turbocharged diesel engines each having a horsepower rating of 425 continuous and 600 maximum horsepower. The four engines, with compound for driving as desired, table and the pumps were located on the first deck below the rig floor. The two 7¼ x 17 pumps were located on the next lower deck. Mud storage and mud-mixing equipment were located on the engine deck.

Penetration rates, in the deep water tests, ranged from as fast as the kelly would fall, in very soft sediments and clay, to as slow as 2 to 3 feet per hour in the hard basalt section.

On one of the Guadalupe tests, before coming out of the hole with the pipe, a multi-shot directional survey was run, taking surveys every 1,000 feet up the hole. At near total depth of 160 feet below the ocean floor, deviation was 5 degrees. It was 4½ degrees at the top of the hole and gradually decreased toward the surface. In the fifth and sixth holes at Guadalupe, experimental runs were made with a turbodrill.

Cores recovered at Guadalupe ranged from soft, gray-green clay of Miocene age, to a hard, fine-grained, gray-to-black volcanic basalt. Basalt, encountered for the first time in Hole 2, was topped at 560 feet. Drilling and coring continued in basalt to total depth of that hole, 601 feet. This was the greatest depth attained at that site. Finding of the basalt verified early seismic surveys in that area. However, finding of basalt, in itself, was not an unusual occurrence inasmuch as it is found interbedded in

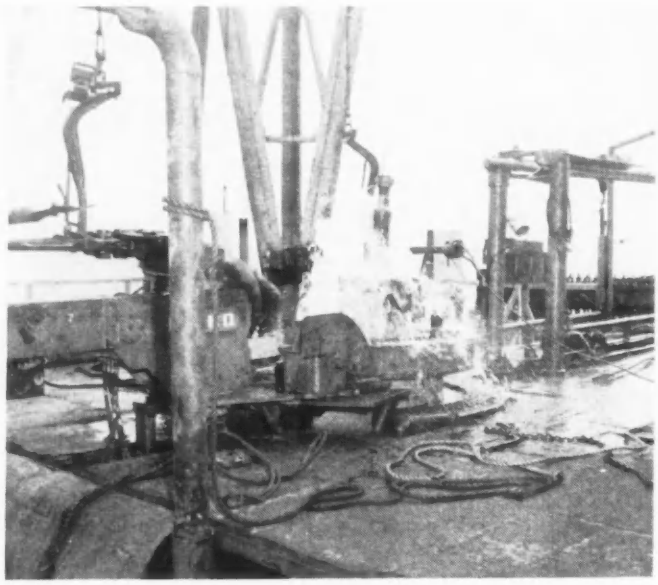
Lower section of special guide shoe being installed in well of CUSS I. Shoe, with a maximum diameter of 58 inches at its widest—and lowest—point, prevents concentration of stresses in drill pipe at point where it leaves the ship. Shoe limits bending as ship rolls.



View taken from above center well in CUSS I showing top section of special guide shoe which prevents excessive bending of drill pipe as ship rolls. Lower section of guide shoe extends from about water level on down below keel of ship.

Oil industry personnel, equipment and technology will undoubtedly play a vital role in Mohole Phase 2

Engineers inspect diamond bit as it is pulled from hole after making run in deep water drilling off Guadalupe Island.



Pulling wire line core barrel spills sea water over rotary table and rig floor. In right background can be seen part of pipe racking system which permits pulling and laying down in doubles. Skate, on which pipe rides out to end of rack, is partially visible in alley at walk level.

Scientists aboard CUSS I carefully remove mud from section of core just removed from diamond core barrel pulled from hole at the Guadalupe Island site.

Willard Bascom (right) Project Director for the Mohole experimental drilling program, chats with the project's superintendent, C. Don Woodward (center) and D. C. (Buz) Freeze, drilling superintendent for Global Marine Exploration, contractor on the job.

Miocene sediments in at least one or two California oil fields. As much as 1,000 to 1,500 feet of basalt must be drilled, in some cases, to reach underlying productive formations.

Phase I of the experimental Mohole project, just concluded, answered many questions and posed many others. But results point the way to techniques and equipment that will be needed for the final Mohole at a future site. Ultimate objective of that hole will be the Mohorovicic Discontinuity, Moho for short, which may require drilling to depths in the order of 32,000 to 50,000 feet.

Thanks to the engineering skill, ingenuity and the vast sums of money spent by industry in developing floating techniques, the recent Guadalupe tests probably occurred much sooner than they otherwise might have been. And, when Phase II, the deep drilling project begins, it is certain that the oil industry, its equipment and technology will play leading roles.

—The End

A WORLD OIL INTERVIEW WITH

C. M. SHIELDS, senior engineer, equipment and design, Standard Oil Company of California, La Habra.

and . . .

A. J. FIELD, vice president and general manager, Global Marine Exploration Company, Los Angeles.

Which shows faster payout,

platforms or ocean floor completions?

As the search for oil and gas moves farther out to sea, interest in underwater well completions and drilling from floating vessels increases.

For the past several months offshore operators have been keeping a close watch on submarine completions off the coasts of Peru, California and Louisiana. Although little technical information has been released concerning these pioneering efforts, it appears certain that this type of completion is a mechanical success. Economics and availability of equipment now pose the big questions.

So that World Oil readers might have a full report on these and other questions that have arisen concerning underwater completions, the Editorial Staff conducted exclusive interviews with two top authorities: C. M. Shields, senior engineer, equipment and design, Standard Oil Company of California, and A. J. Field, vice president and general manager, Global Marine Exploration Company.

Their personal views on the engineering and economic aspects of underwater completions are expressed in the following interview.

Q. *What is behind the apparently increased interest, during the past year or two, in ocean floor completed wells?*

A. Shields: There are many reasons, but the principal one is the possible economic advantage of submarine wells. Multi-well platforms in deep water are very expensive and, as water depth increases, so do platform costs. So the principal incentive is one of economics, trying to eliminate or reduce high platform investments.
Field: High platform costs and the ever present possibility of misplacement of a costly platform are factors. Another and perhaps the most important factor has been the pressure on the world's crude oil prices due to a continued oversupply. This has made it necessary to find less expensive ways of producing offshore oil.

Q. *Are there other considerations which might make undersea completions more attractive?*

A. Field: There are several very good engineering reasons for subsea wellhead completions. In locating wellheads below the sea, it is possible to minimize corrosion, minimize sea growth, avoid dangers of collision by ships, and minimize forces on the structures due to wave action.
Shields: I agree, and might point to a few examples wherein some factors other than economic make underwater completions attractive. If, for example, an oil field were discovered in the outer Los Angeles harbor or in the shipping lanes in that general area, the presence of drilling platforms would be a real hazard.

Another factor to consider, in California, is the state law which, for certain offshore parcels, prohibits placing a platform within one mile of shore. Not all California offshore parcels have this restriction, but certain of those in the Santa Barbara area do have that provision.

Another example where submarine completed wells might offer an advantage is in the far north, where icebergs or iceflows, and their possible collision with platforms, would create some hazard. This could be eliminated by completing the wells on the ocean floor.

Q. *What are the cost advantages of the ocean floor type completion vs. the fixed platform completion?*

A. Field: Conditions surrounding each oil field and each drilling situation present their own economic problems and their own particular cost comparisons. We have

made a study of the cost advantage of a particular oil field in 100 feet of water. Besides the initial saving in the cost of the platform, which in itself, might be $4 or $5 million, there is a saving in the maintenance cost of that platform through the years.

A big cost advantage exists, also, in the timing of expenditures in the development of an oil field. The use of money is worth money, and, in avoiding the large capital expenditure early in the life of an oil field, the rate of return on invested capital for this particular field problem we analyzed showed a difference of three or four times the rate of return on invested capital for the subsea completed oil field.

Shields: Risks and other intangible factors must be considered, but it would seem that conditions favoring fixed platforms would be those prospects where the producing horizons are fairly deep, where the bottom hole spacing is close and where the water depths are less than 200 feet. Under these conditions a large number of wells could be drilled from one platform.

On the other hand, a prospect better suited for submarine completion might be in deeper water where the producing zone would be fairly shallow and where well spacing is wider. With a shallow producing horizon, directional drilling becomes either impossible or very expensive, and the number of wells per platform is quite low.

Therefore, platform cost per well becomes significant. Under ideal conditions for submarine completions, it might be possible to save as much as half of the platform costs. I would expect that operating costs would be somewhat higher with submarine wells than with platform wells but, until a few completions are made and some experience gained, I don't believe it would be possible to arrive at a good comparison of operating costs.

Q. *The several recently announced underwater completions have been in relatively shallow water. Would you say the cost advantages of such completions appear attractive?*

A. Shields: It is my guess that recent submarine completions have been of a test nature, where the operators are attempting to prove out equipment and to obtain operating information. Perhaps there was an economic advantage in completing these particular wells on the ocean floor, but it's my guess that these first installations were justified primarily on a test basis.

Field: In this connection, I recently was talking with a production manager of a major company who said whenever they are forced to work out methods for deep water subsea wellhead completions they probably would adapt the same techniques, within a year or two, to completions in swamp areas. Economic advantages are there, he felt, even in very shallow water.

Q. *Would ocean floor type completions require greater investments in submarine pipe lines, or gathering lines, thus partially cancelling out some of the original advantages?*

A. Shields: Yes, this is one of the more important economic considerations when comparing platform wells with submarine completions. I have no good figures, but it would appear that submarine wells would require more individual lines than platform wells and, thus, some of the economic advantages would be cancelled out. However, in looking ahead a few years, it's possible that submarine systems could be simplified, so that submarine pipe line costs might not be much greater than costs associated with platform wells.

Fields: It cannot be overemphasized that each field, and each well in the field, presents its own economic problem as to drilling completions and producing operations. I agree that presently there are and always will be some fields which will lend themselves more economically to an above-water platform completion.

However, I feel that with the majority of fields, the subsea wellhead completion will be the economic route. Pipe lines and flowlines are one facet of this over-all economic problem. It should be pointed out that, all other conditions permitting, subsea wells could be grouped on the ocean floor just as though they were on a platform.

Q. *Are there other intangibles that should be considered in weighing submarine completions with the platform approach?*

A. Shields: Yes, in addition to those already mentioned there are other intangible factors and risks that must be considered in making the decision. Among them are:

1. The areal extent of the reservoir. A small elongated or disjointed field might favor ocean floor completions, whereas, in a large field there might not be much difference.

2. Platform life and the ease of replacement. This, I think, favors submerged wells.

3. Probability of requiring replacement. This might favor submerged wells although there may not be too much difference.

4. Directional drilling costs. This certainly would favor submerged wells since directional drilling is minimized.

5. Artificial lift of wells. This undoubtedly would favor platform wells, not only from the standpoint of cost but from the standpoint of methods presently available.

6. Well servicing. This might be done easier and cheaper from a conventional platform.

7. Risks of fire or collision. There is a risk associated with a high wellhead concentration on a platform from the standpoint of blowouts and fires. In this regard, the risks might favor submarine completions. The risk of collision also would favor submarine completions.

8. Storm damage. Submarine completions might be favored under severe storm conditions.

9. Control in emergencies. With existing schemes, this consideration would favor platform completions.

Field: I might add several more points that influence development operations. These are water depth, bottom condition as it affects foundation and drilling problems, wave and weather conditions, distance from port and shore, drill depth and casing program, and productivity of the field.

Over-all consideration of these physical factors leads to forming a plan for the most economic method of operation for a particular field or area. Important, too, is the fact that with subsea wellheads it is likely that the economic life of a reservoir probably will be extended farther than with other completion methods. This would be due to the

cost of maintenance or replacement of the platform. This is particularly true of shallow reserves.

Q. *Do you feel most major problems and techniques have been sufficiently worked out that an operator now could confidently plan an extensive sea-floor completion program?*

A. Shields: Yes, vessels, equipment and manpower are available.

Field: It is our feeling, too, that regular off-the-shelf hardware has been available for at least two years from various wellhead manufacturers. Availability of this equipment can make possible sea-floor completion programs, using floating drilling vessels, in a more or less conventional manner, at least insofar as wellhead design is concerned.

Operational procedures and skills in this type of drilling have been refined to the point that, for the last two years or more, operations are routine, safe and efficient.

Q. *It has been said that when working from a floating vessel, a greater water depth actually works to a good advantage. Would you amplify on this?*

A. Field: It is impossible to prevent movement when anchoring any floating vessel or object where it is subject to waves and swell action. Any anchor system must be inherently elastic. The wellhead, in order to be as safe as possible, must be as far away as possible from the moving vessel. It is, therefore, obvious that the safest place for the wellhead is on the sea floor, or at the very least, a considerable distance from the vessel.

The problem then, in floating rig drilling, is to design flexible connections between the wellhead and the ship to allow the operation of conventional drilling tools and equipment. It is estimated that an allowable horizontal movement for a drilling ship could be as much as 10 percent of the water depth.

Shields: Anchoring systems now used on floating vessels will minimize the horizontal movement of the vessel under normal weather conditions, but such movement is an important consideration when drilling in shallower waters. There are two critical stress points in the drill string: at the rotary table and at the ocean floor. Means are available for limiting the bending stress in drill pipe at the rotary table, one method being to mount the table on gimbals.

Stresses in the drill pipe at the ocean floor, however, are a function of the lateral displacement of the vessel as well as the weight of drill pipe below the ocean floor. It's obvious that in water of depths of, say, 100 feet that a 10-foot displacement of the vessel is much more severe than a 10-foot displacement in water depths of 200 feet. Therefore, it is generally considered that as water depths increase, displacement of the vessel becomes less important.

Q. *To efficiently complete ocean floor wells, it is necessary to have some type of reliable remote hanger for intermediate casing strings. What has been done to solve this problem?*

A. Shields: Although it is feasible to hang casing on slips in the conventional manner, this method is somewhat difficult to use because it requires that the pipe be cut off just above the slips with internal cutters. While this is possible, it is a little more difficult to accomplish from a floating vessel than from a fixed platform.

Because of this problem a mandrel type of suspension can be used which automatically locks the casing into position and simultaneously seals off the annulus. Another method is to cement the casing string full length up to the ocean floor. Both of these methods have some inherent disadvantages, but with proper precautions and technique both have been used quite successfully.

Field: A reliable remote hanger of intermediate casing strings is certainly a very desirable tool. They are available, are safe, and have been field tested. However, it has been found that divers can work quite efficiently in flanging up and handling conventional wellhead equipment on the sea floor.

Q. *Another need is for some type of reliable remote flanging system. What has been done in overcoming this problem and are divers normally required for this phase of operations?*

A. Field: There is a remote flanging system available which has been used many times in the last few years, and is manufactured by a reliable wellhead manufacturer. Also, it has been proven that divers can handle flanging operations under water with the various types of on-the-shelf flanges which are available.

Shields: Equipment is available that would preclude the use of divers and two or three of the wellhead manufacturers have devised methods of connecting blow-out preventers and wellheads. The most widely used piece of equipment for this purpose is the casing safety joint made by one tool manufacturer. Some types of automated clamp type connections also are available.

Q. *Has wellhead equipment been conventional (except for corrosion protection) or has it been of a specially-designed nature?*

A. Shields: The only submarine completions that I know of where conventional wellhead equipment has been used is in the Great Lakes area, where fairly shallow, low-pressure gas wells have been completed on the lake bottom. On the recently announced ocean floor completions, I believe wellhead equipment has been of a very special nature.

Field: On present subsea completions, wellhead equipment has been of special design. As we understand it, operators are successfully using remote actuating casing hangers and flanges.

Q. *What is the maximum efficient depth in which divers can work?*

A. Shields: There is a practical limit, I believe, beyond which divers cannot be expected to accomplish much physical work or beyond which the costs of diving become quite high. As a general rule, about 200 to 225 feet is considered a practical limit.

Field: Although we have used certain divers effectively in 270 feet of water, we feel, as a general rule, that 200 feet is about a limit for any hard work other than observation.

Q. *Do you see underwater television assuming an increasing role in deep water operations?*

A. Field: We have used underwater television operationally since 1953. It has been reliable and useful once initial development bugs were worked out. We also found that the problem with TV was in learning not only how

to make it operate but also in handling it underwater to accomplish the desired results.

Shields: Most of the floating drilling ships used off the coast of California have been equipped with some type of underwater television equipment. This equipment has been used extensively in core hole drilling. I don't know of any particular limitations in the TV equipment now being used. It has been our experience, however, that lighting has been a problem and pictures sometimes are not as clear as one might want them to be.

Q. *Are there any major problems in operating underwater completions from their flowing stage to abandonment?*

A. Field. We think there are three major methods by which artificial lift can be accomplished: reservoir pressure maintenance to keep reservoir pressures high, gas lift and hydraulic pumping. Selection will depend upon the individual situation.

Shields: No, I don't believe there are any major problems. Gas lift and subsurface hydraulic pumps can be used after flowing ceases. Neither of these methods presents any major problem in an ocean floor completion.

Q. *What do you see as the probable answer to maintenance and workovers?*

A. Shields: Looking into the future a few years, I would guess that permanent-type well completions, using wire line techniques, would offer the best means. So far as replacement of wellhead equipment is concerned, I don't believe this presents any problem other than that associated with the limitations on diving.

Field: It is my opinion that maintenance and workovers could be accomplished with smaller pulling rigs mounted on vessels of various sizes. For work inside tubing, a 60-to 100-foot vessel would be adequate for pulling tubing and for workover jobs, and probably one of the smaller drilling vessels already in existence would provide a good model.

Q. *Would a sea-floor completed well have a shorter economic life than a comparable platform-completed well?*

A. Shields: My guess is that because of the probable higher cost of operating there would be a shorter economic life to the submarine completed wells. I think the answer to this question, as well as to many of the other questions, can be determined only by making test installations and gathering operating data.

Field: The subsea well in my opinion, might have a longer life. This would be due to the problems and expense of maintaining a platform structure, whereas the subsea head is located well away from major factors of corrosion, wave force and sea growth.

Q. *Looking toward the end of the productive life of an offshore field, would recoverable salvage be greater or less for a dozen wells completed on the sea floor as compared with an equal number completed from a fixed platform?*

A. Shields: Here, again, we can only generalize. Except in rare cases, it's unlikely that salvage value of offshore platforms would be enough to pay for their removal. On submarine wells, the structure has been minimized and there would be little or no salvage value in the hardware. There might be a higher salvage value, however, in the submarine lines. I don't believe that salvage value at this stage is too important a consideration.

Field: We think there would be little significant recoverable salvage in either case.

Q. *It has been said that in a short time most offshore wells will be drilled using the floating vessel method. Do you think this would apply to offshore operations all over the world?*

A. Shields: My personal opinion on this is that where water depths permit, operations can be more effectively handled from mobile platforms than from floating vessels. However, mobile platforms are limited by water depth. And, as exploratory activity in offshore areas increases we are going to see greater and greater use made of floating vessels.

It also is my opinion that fixed drilling and producing platforms always will be used in certain areas simply because they will be more economic.

Field: We feel that a majority of future offshore drilling will be done from mobile floating units, with wellheads completed above or below the water surface. Above-water platforms are economic when they can be so surely placed as to assure that tens of millions of barrels can be produced through each platform. A study of capital cost of mobile platforms indicates that at about 45 feet of water the capital cost of a floating vessel is less than the cost of a mobile platform. This might indicate the cross-over.

Note: The opinions expressed by the authors are primarily from an engineering and economic viewpoint and do not necessarily reflect the views or over-all policy problems of their companies or of offshore operators in general.

—**The End**

C. M. Shields is senior engineer, equipment and design, at the southern division producing department headquarters, La Habra, of Standard Oil Company of California. After spending four years as a Naval aviator during the war, he attended University of Southern California, graduating in 1948 with a B.S. degree in mechanical engineering. He joined Standard and served in a number of capacities, including two years as a drilling engineer and two years as production equipment engineer at the La Habra office, followed by a short period as wage and salary analyst in the San Francisco headquarters office. In 1953 he was made lead production equipment engineer and, two years later, was promoted to assistant production foreman. In 1955 he was made senior engineer, the position he now holds.

A. J. Field vice president and general manager of Global Marine Exploration Co., received a B.S. degree in civil engineering from California Institute of Technology in 1944. He served with the U.S. Navy Seabees in the Pacific as an engineer in waterfront construction work. After the war he obtained an M.S. degree in civil engineering from Stanford University. He joined Union Oil Company of California in 1947 as a roustabout and, after working as well puller, rotary helper and drilling foreman, he joined the CUSS Offshore Group staff in 1953 where he was responsible for petroleum engineering and economics. He has been in his present capacity with Global Marine Exploration Co. since 1958.

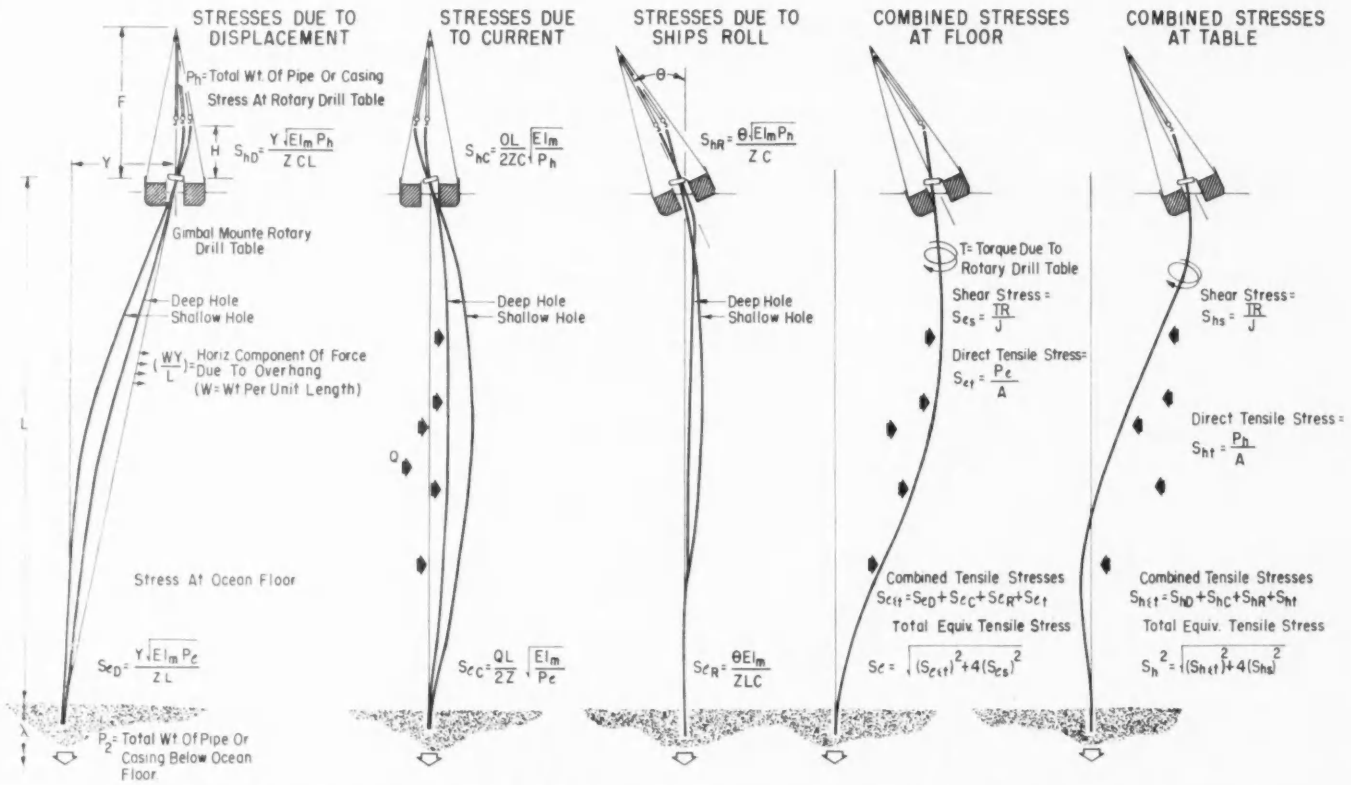

STRESSES DUE TO DISPLACEMENT
STRESSES DUE TO CURRENT
STRESSES DUE TO SHIPS ROLL
COMBINED STRESSES AT FLOOR
COMBINED STRESSES AT TABLE
Ph=Total Wt Of Pipe Or Casing
Stress At Rotary Drill Table
Gimbal Mounte Rotary Drill Table
Deep Hole
Shallow Hole
Horiz Component Of Force Due To Overhang (W=Wt Per Unit Length)
Stress At Ocean Floor
P2=Total Wt Of Pipe Or Casing Below Ocean Floor
T=Torque Due To Rotary Drill Table
Shear Stress=
Direct Tensile Stress=
Combined Tensile Stresses
Total Equiv Tensile Stress
Shear Stress=
Direct Tensile Stress=
Combined Tensile Stresses
Total Equiv. Tensile Stress

FIGURE 1—Here is shown an analysis of drill string or casing stresses while drilling from a floating vessel.

How to evaluate pipe stresses when drilling from a floating vessel

The following stresses increase with hole depth:

- Axial tensile stress due to the weight of the tubing
- Bending stress due to the vessel being displaced from over the hole
- Bending stress due to the vessel roll

By Edward R. Lind, Engineer
Engineering Dept., Standard Oil Company of California, San Francisco

WHEN DRILLING FROM A FLOATING VESSEL, bending stresses due to the roll of the ship, displacement of the ship from over the hole and ocean current drag force must be added to the usual drilling stresses. As the hole depth increases, the roll and/or displacement limits must be decreased to prevent over-stressing the pipe.

To prevent failure by bending or breaking, it is necessary to keep the maximum total stress below a pre-determined maximum allowable working stress. This maximum allowable working stress depends upon all of the physical properties of the string plus the past history of operation. Maximum allowable working stress can only be determined by operating experience. Until sufficient experience is obtained to determine the maximum allowable working stress, it is suggested that the same practice used

for drilling on land be considered for all non-critical operations.

Stresses considered. The following stresses normally encountered in oil well drilling have been considered such as:

- Axial tensile stress due to the weight of the tubing.
- Shear stress due to the rotation when drilling.
- Stress due to internal fluid pressure.

When drilling from a floating vessel, the following bending stresses need also be considered:

- Bending stress due to the vessel being displaced from over the hole.
- Bending stress due to the vessel roll.
- Bending stress due to the ocean current drag force.

Figure 1 shows these various stresses with simplified formulas. Formulas have been derived for the total combined stresses due to all of the forces listed above.

When starting a critical operation (danger of blowout), only new tubing or very carefully inspected tubing should be used between the vessel and the ocean floor (area subjected to cyclic loading). If there is a chance tubing may have been exposed to cyclic loading, or if cyclic loading is expected, maximum stress should be limited to 25,000 psi regardless of grade of steel being used. With cyclic loading, there is always danger of fatigue failure.

Formulas have been derived for the bending stresses caused by the vessel being displaced from over the hole, the vessel rolling and effect of ocean current drag force. The formulas cover most conditions of water depths and hole depths expected to be encountered in offshore drilling. Extensive experience has been obtained for the case of shallow holes during the past several years while core drilling off the coast of California.

Basic equations can be modified as required for various methods of operation. For this presentation, a gimbal-mounted rotary table is assumed.

The total stress and, therefore, the possibility of bending or breaking the drilling string or casing increase as the hole depth increases. When drilling from a floating vessel, this becomes a problem as the hole depth approaches 5,000 feet and becomes a serious problem at 10,000 feet.

Though calculations indicate that excessively high stresses are possible when using present drilling methods, minor modifications of procedure and the use of simple attachments can reduce these stresses.

Methods of reducing or limiting stresses. Modifying drilling procedure and/or adding equipment may possibly extend stress limits, i.e.,

- Shut down drilling during periods of excessive roll and displacement.
- Use tapered drill strings—this may increase the allowable roll and displacement approximately 25 percent.
- Increase the size of the kelly and provide a tapered sub between the kelly and the drill tubing. The limitation for roll and displacement at the top can be approximately doubled.
- Use a gimbal-mounted table and mast, or by use of a power swivel.
- Provide a guide to limit the minimum radius of curvature of the pipe.
- Use aluminum tubing for drilling which greatly reduces the stress since its weight in water is much less than the weight of steel. Also, the bending stresses are reduced because the modulus of elasticity is only one-third for that of steel.

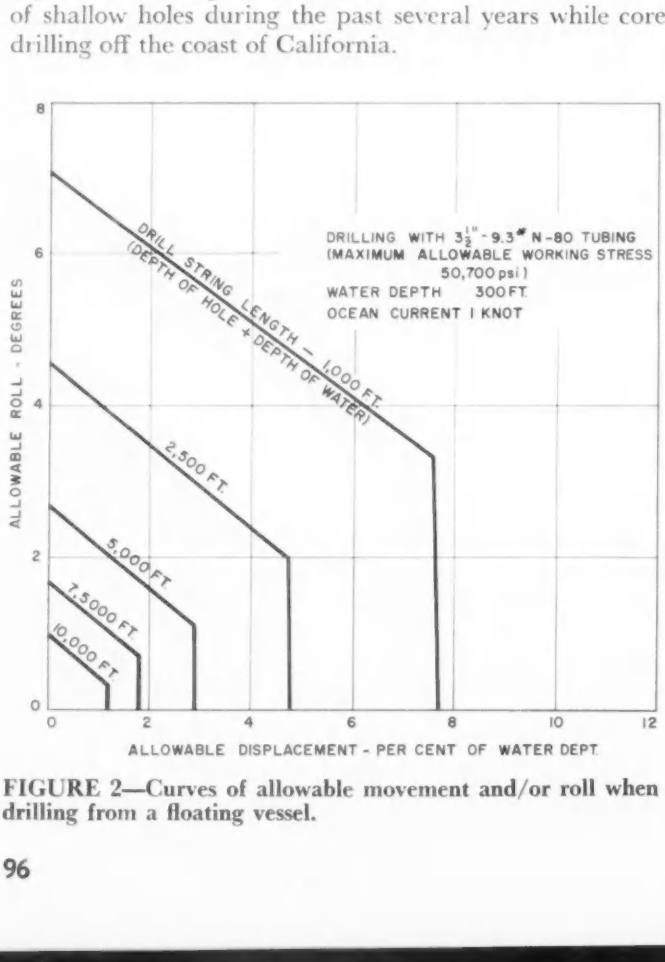


FIGURE 2—Curves of allowable movement and/or roll when drilling from a floating vessel.

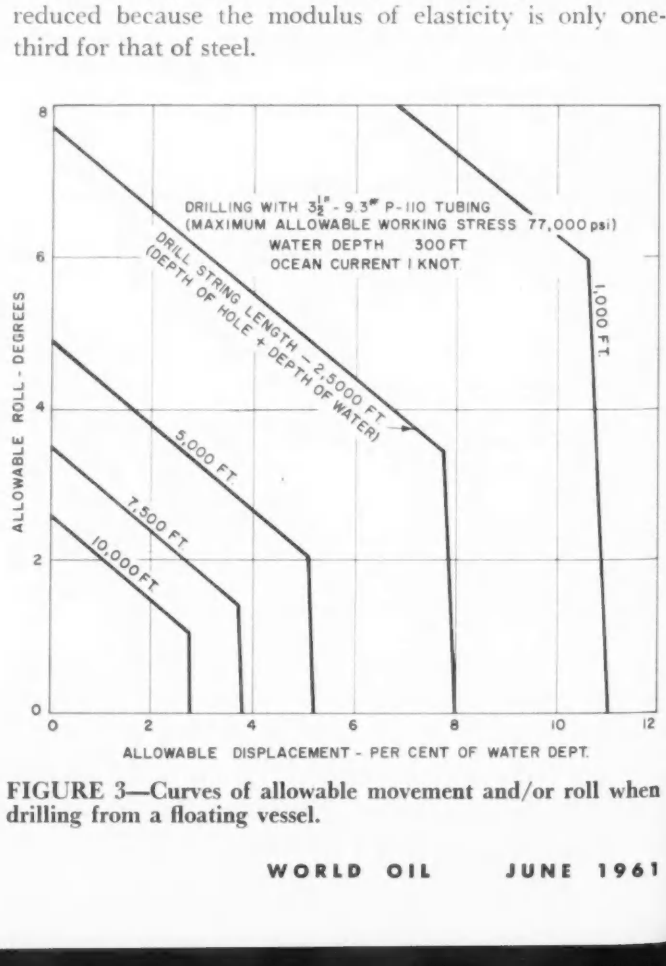


FIGURE 3—Curves of allowable movement and/or roll when drilling from a floating vessel.

• Use a turbo-drill which will remove the shear stress due to rotation of the shaft and also reduce the possibility of failure due to fatigue.

Analysis of stresses. As the hole depth increases the following stresses are increased:

• Axial tensile stress due to the weight of the tubing.

• Bending stress due to vessel being displaced from over the hole.

• Bending stress due to the vessel roll.

The formula for determining the direct tensile stress is conventional. That is, the stress equals the weight divided by cross sectional area of the supporting member.

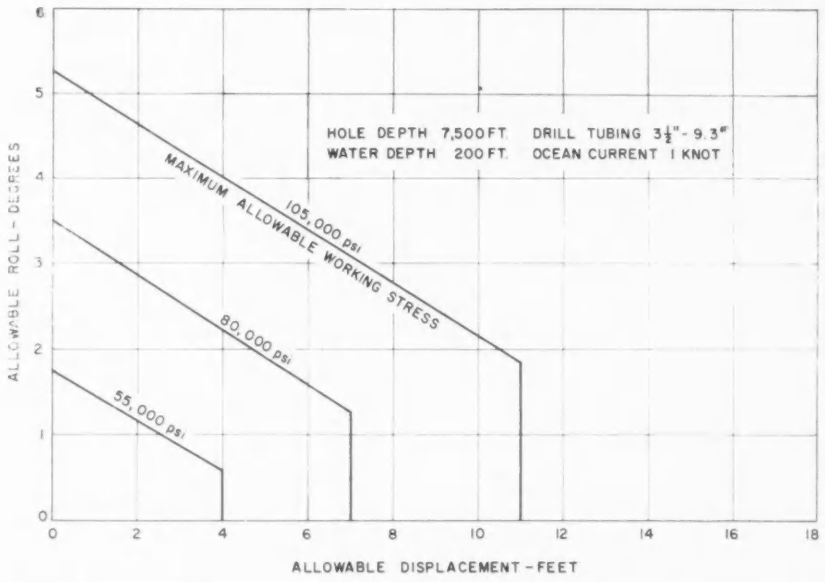


FIGURE 4—Limits of roll and displacements for various maximum allowable stresses.

In analyzing the stresses involved when drilling from a floating vessel, it is necessary to consider the significance of the shape of the deflection curve for the drill or casing string through the water when the ship is rolling or is not directly over the hole (See Figure 1). For reasonably deep water, with high axial tension in the pipe, the deflection curve is essentially a straight line, as for a taut string. Thus, most of the curvature is concentrated as a fairly sharp angular deflection near the ocean floor and near the ship with consequent high stresses at these points.

The bending stresses are directly additive to the tensile stress. It is assumed that the direction of displacement, roll and current are such as to cause all of these to be additive.

For deep holes (over 5,000 feet), it is necessary to consider that the bending stress, proportioned to curvature and diameter for a given modulus of elasticity, will be increased by an increase of tension and reduced by an increase of pipe stiffness. Mathematical analysis of the situation leads to the following equation of proportionality for the effect of angular deflection (roll or displacement.)

$$S \propto \beta ED \sqrt{\frac{P}{EI}}$$

This equation acquires more practical significance when we note that for a string of uniform size, approximately,

$$I \propto D^3t \text{ or } I \propto (D^4 - d^4) \text{ and } P \propto \rho \lambda (D^2 - d^2)$$

Then,

$$S \propto \beta \sqrt{\frac{EP}{Dt}} \quad \text{or } S \propto \beta \sqrt{\rho \lambda E}$$

Therefore,

1. Bending stress is directly proportional to angular deflection. Thus, the stress at the ocean bottom is directly proportional to the ratio of lateral vessel displacement to water depth. At the vessel, the angle of roll must be added to the displacement in determining the angular deflection (β).

2. The bending stress is directly proportional to the square root of axial tension. Thus, the bending stress increases approximately as the square root of the depth of hole.

3. The bending stress is inversely proportional to the product of thickness times diameter which is, in turn, proportional to the weight per foot of pipe. But the tension, P, is also essentially proportional to the weight per foot; therefore, the bending stress becomes independent of pipe diameter and thickness for a string of uniform size.

4. The bending stress is proportional to the square root of the modulus of elasticity. This may, at first, appear anomalous since a reduction of modulus of elasticity obviously increased the curvature with a proportional increase of unit strain. Stress, however, equals strain times modulus of elasticity—and this product is reduced by a reduction of modulus of elasticity.

The effect of axial tension on stress due to ocean current is opposite to its effect on stress due to angular deflection; the axial tension straightens the pipe and reduces the stress due to ocean current.

For deep holes, this stress becomes small except for cases of very deep water or strong currents.

Simplified formulas for deep holes. Most of the problems of excessive stress will be associated with deep holes; therefore, a simplified set of formulas are presented in Appendix A for this use. These apply to uniform (not tapered or combination) strings when:

$$U_l = \sqrt{\frac{P_l L^2}{EI_m}} > 40 \text{ and } U_h = \sqrt{\frac{P_h H^2}{EI_h}} > 4.$$

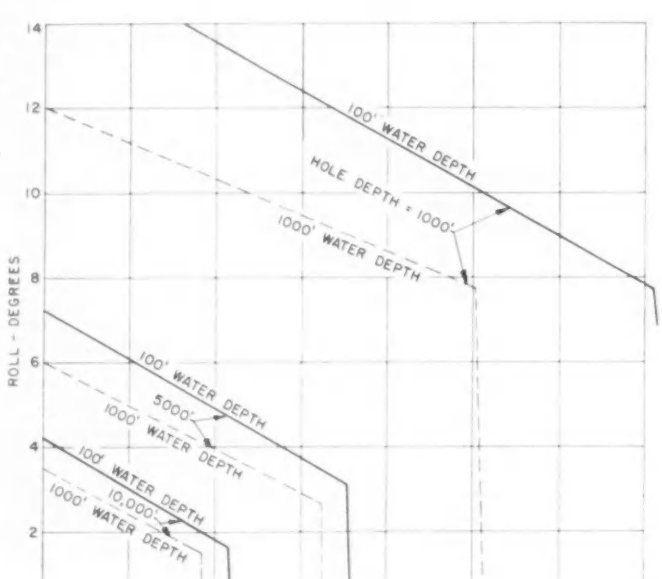


FIGURE 5—Limits of roll and displacement showing effects of various water depths.

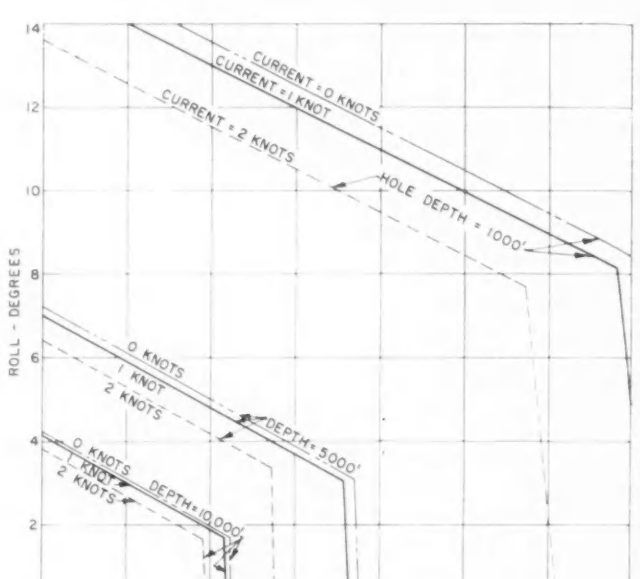


FIGURE 6—Limits of roll and displacement showing effects of various ocean current velocities.

When drilling deep holes, the following may be used for a rough check of stresses:

		Conditions at top	Conditions at Bottom
Direct tensile stress	S_t	$3.3\ (\lambda' + L')$	$3.3\ (\lambda')$
Bending stress due to:			
Displacement	S_D	$9{,}000\ (Y/L)\ (\lambda')^{1/2}$	$15{,}000\ (Y/L)\ (\lambda')^{1/2}$
Roll	S_R	$160\ (\Theta^\circ)\ (\lambda')^{1/2}$	Negligible
Ocean current	S_C	Negligible	Negligible

Calculations of the limits of displacement and roll. The stress formulas referred to above permit calculating the maximum total stress for any specific condition, but does not provide information as to the limits of roll or displacement. When a drilling site is selected, the following information is known, can be estimated, or can be controlled:

Known: Water depth and tubing to be used

Estimated: Maximum ocean current (an error in this estimate has negligible effect except for a shallow hole in deep water with a strong current)

Controlled: Design the rotary table to limit the torque applied when drilling

Remaining variables: Hole depth, roll, and displacement from over the hole.

As pointed out above, the displacement and/or the roll will cause stresses in the string that are added to the direct tensile stress. All of these stresses increase as the hole gets deeper. Therefore, as the hole depth increases, the displacement and/or roll limitations must become less. For a given site and assumed maximum allowable stress, curves can be prepared giving limits of displacement and/or roll for various depths of hole.

These curves will be very conservative, and it is possible to operate occasionally in excess of these recommended limits because:

1. The maximum allowable working stress usually is less than the minimum yield strength for tubing used.

2. A conservative allowance usually is provided to allow for overcoming friction when pulling tubing from the hole.

3. Maximum computed stress assumes all adverse conditions at a maximum.

4. Any yielding of the soil or loose fitting of the drill tubing in the BOP assembly will reduce the calculated stresses.

Limits have been calculated for 3½-inch-9.3 pound drill tubing. These are presented in Figures 2 and 3. These curves have been prepared for a specific case, but these curves are approximately correct for the following range of conditions for the case of a deep hole.

Maximum allowable working stress. The fatigue problem when drilling from a floating vessel is influenced by:

- The material used.
- Number and amplitude of cyclic stresses.
- Notches, scratches, or other irregularities on the surface of the pipe.
- Strength of the threaded joints. (This should not be a problem because pipe should be heavier at the joints.)
- Reduction of strength due to stress corrosion.

Only through operating experience will it be possible to determine the effect of these factors and therefore determine the maximum allowable working stress.

The selection of an API grade tubing controls the material, method of fabrication, and the minimum yield strength. The maximum allowable stress is reduced to allow for:

- Corrosion of drill string
- Reduced area due to abrasion
- Shock loading.

In addition, an allowance is provided to permit pulling the drill string and to provide an adequate allowance for the stress due to rotation and internal fluid pressure when drilling. This assumes maximum pull will not be applied when maximum torque is applied.

Without operating experience, it is feasible to consider the maximum allowable stress to be the same as when drilling on land because:

1. The direct tensile stress is maximum during the period of pulling, and at this time the cyclic stresses are a minimum.

2. The cyclic stresses are not complete reversals of stress once the direct tensile load remains somewhat constant and only the bending component is cycled.

3. The bending stress due to roll of the vessel is maximum only at the point of maximum roll to the side opposite that of the displacement.

4. In determining the maximum bending stress at the top due to roll and/or displacement, it is assumed that the kelly is at the maximum height. This occurs only as each new length of tubing is started. The bending stresses are reduced as the kelly moves downward.

5. The bending stress at the bottom is reduced by any clearance between the drill tubing and the blow-out preventer.

6. Any yielding of the soil will reduce the bending stress at the ocean floor.

Because there always is the possibility of fatigue failure, it is recommended that only new or fully inspected drill tubing be used between the vessel and the ocean floor if a hazardous operation is undertaken.

Effect of various hole depths. The direct tensile stress due to weight of string varies directly with hole depth.

The bending stress due to ship's roll or displacement from over the hole varies as the square root of the hole depth.

These effects are shown in the following example:

Drilling with: 3½ inch-9.3 pound tubing.
Water depth: 200 feet — Vessel roll: 3 degrees
Ocean current: 1 knot — Vessel displacement: 5 feet

	Stress in psi for		
Hole depths of	1000′	5000′	10,000′
Max. stress at ocean floor due to:			
Weight of string	4,000	17,000	35,000
Ocean current drag force	5,000	3,000	2,000
Roll of vessel	2,000	1,000	1,000
Displacement of vessel	17,000	30,000	40,000
Total Tensile Stress	28,000	51,000	78,000
Max. stress at rotary table due to:			
Weight of string	4,000	17,000	35,000
Ocean current drag force	4,000	2,000	1,000
Roll of vessel	18,000	33,000	50,000
Displacement of vessel	7,000	17,000	23,000
Total Tensile Stress	33,000	69,000	109,000

Note that the bending stress due to the ocean current drag force decreases as the hole depth increases. For a very deep hole, this stress becomes negligible.

Effect of various materials (allowable stress). The API grade of tubing significantly affects the maximum allowable working stress. For a given depth, the direct axial stress and the stress due to the rotation is not affected by the ocean condition. The stress due to the ocean current drag force is small. For a 7,500-foot-deep hole and currents less than one knot, the total of these stresses will be approximately 30,000 psi. See Figure 4 for examples of allowable roll and/or displacement when the various maximum allowable working stresses have been reduced by a constant 30,000 psi to allow for axial tension, rotary shear and bending due to ocean current drag forces. Note that the remaining allowable stress for roll and/or displacement increases much more percentagewise (thereby allowing greater roll and/or displacement) than the increase in maximum allowable working stress.

Effect of various water depths for deep holes. As shown by Figure 5, if the ratio (or percentage) of displacement to water depth is used as the allowable displacement, the water depth has little effect on the other conditions for deep holes. Most of the variation is due to the increased weight of the tubing between the ocean floor and the ship. For example, to drill a 1,000-foot hole in 1,000 feet of water requires 2,000 feet of tubing.

Effect of various ocean currents for deep holes. As shown by Figure 6, normal ocean currents have very little effect on limits for deep holes. The bending stress due to ocean current drag varies inversely as the square root of the hole depth.

Effect of various diameter and thickness of tubing. For deep holes and uniform (non-tapered) drill or casing strings, the diameter and thickness has very little effect on the axial tensile stress or the bending stresses due to ship's roll or displacement. Therefore the diameter and thickness has very little effect on the total stress for deep holes since these are the most significant stresses. The bending stress due to the ocean current drag force is reduced by larger and thicker tubing.

For uniform strings, the following relationships are proportional to the diameter and thickness. These are presented as outside diameter (D) and inside diameter (d).

Total weight	$P \propto C_W \rho \lambda (D^2 - d^2)$
Cross sectional area	$A \propto (D^2 - d^2)$
Moment of inertia	$I \propto (D^4 - d^4)$
Ocean drag force	$QL \propto V^2DL$

where:

APPENDIX A

For Deep Holes ($U_l > 40$ and $U_h > 4$) $C \simeq 1 + \sqrt{I_m/I_h}$

New Symbols Used:

λ = Depth of Hole (λ' in feet)
ρ_P = Density of tubing (0.284 lbs/in^3)
ρ_W = Density of water (.037 lbs/in^3)
$C_W = \dfrac{\text{Wt. per Ft. incl. Couplings and/or joints}}{\text{Wt. per Ft. with plain ends}}$

D = O.D. of tubing
d = I.D. of tubing
t = Thickness of tubing
C_Q = Drag coeff. = 1.2

Units in lbs. & inches except as noted below

$$S_t = (\rho_p - \rho_w)\lambda C_w \qquad = 2.97\lambda' C_w \qquad \lambda' \text{ — Ft.}$$

$$S_{lD} \simeq 2\sqrt{(\rho_p - \rho_w)E} \times \frac{Y}{L} \times \frac{\sqrt{\lambda C_w}}{\sqrt{1+(d/D)^2}} \qquad \simeq 18{,}880 \times \frac{Y}{L} \times \frac{\sqrt{\lambda' C_w}}{\sqrt{1+(d/D)^2}}$$

(OR)

$$S_{lD} \simeq \sqrt{(\rho_p - \rho_w)E} \times \frac{Y}{L} \times \frac{\sqrt{\lambda C_w}}{\sqrt{0.5 - t/D + (t/D)^2}} \qquad \simeq 9{,}440 \times \frac{Y}{L} \times \frac{\sqrt{\lambda' C_w}}{\sqrt{0.5 - (t/D)}}$$

λ' — Ft.
$\frac{Y}{L}$ — Consistent

$$S_{hR} \simeq 2\sqrt{(\rho_s - \rho_w)E} \times \frac{\theta}{C} \times \frac{\sqrt{\lambda C_w}}{\sqrt{1+(d/D)^2}} \qquad \simeq \frac{330}{C} \times \theta^\circ \times \frac{\sqrt{\lambda' C_w}}{\sqrt{1+(d/D)^2}}$$

(OR)

$$S_{hR} \simeq \sqrt{(\rho_s - \rho_w)E} \times \frac{\theta}{C} \times \frac{\sqrt{\lambda C_w}}{\sqrt{0.5 - t/D + (t/D)^2}} \qquad \simeq \frac{165}{C} \times \theta^\circ \times \frac{\sqrt{\lambda' C_w}}{\sqrt{0.5 - t/D}}$$

$$S_{lR} \simeq \frac{\theta E D}{2LC} \qquad \simeq 21{,}800\,\frac{\theta^\circ D}{L'C}$$

θ — Radians
θ° — Degrees
λ' — Ft.
L' — Ft.

$$S_{lC} \simeq \frac{4\,C_Q \rho_w}{\pi\, 2\,g}\sqrt{\frac{E}{(\rho_p - \rho_w)}} \times \frac{V_o^2 L}{D\sqrt{\lambda C_w}} \times \frac{1}{\sqrt{\left[1-\left(\frac{d}{D}\right)^2\right]\left[1-\left(\frac{d}{D}\right)^4\right]}} \simeq \frac{1177\,V_K^2\,L'}{D\sqrt{\lambda' C_w}\sqrt{\left[1-\left(\frac{d}{D}\right)^2\right]\left[1-\left(\frac{d}{D}\right)^4\right]}}$$

(OR)

$$S_{lC} \simeq \frac{C_Q \rho_w}{\sqrt{2}\,\pi\, 2g}\sqrt{\frac{E}{(\rho_p - \rho_w)}} \times \frac{V_o^2 L}{t\sqrt{\lambda C_w}} \times \frac{1}{\sqrt{4\left(0.25 - \frac{t}{D}\right)}} \simeq \frac{98.2\,V_k^2 L'}{t\sqrt{\lambda' C_w}\ \sqrt{0.25 - t/D}}$$

L' — Ft.
V_k — Knots
λ' — Ft.
V_o — Ft./Sec.

$S_{hD} = S_{lD}/C$

$S_{hC} = S_{lC}/C$

Simplified formulas for calculating stresses in drill tubing or casing while drilling deep holes from a floating vessel.

where:

β = Angular deflection
λ = Depth of hole
ρ = Density of tubing in water
C_W = Ratio of actual weight per foot (including joints) compared to the weight per foot of bare pipe.
E = Modulus of elasticity
L = Water depth
V = Ocean current velocity

Using these relationships, the following proportions for stresses are obtained:

Stress due to	Proportionalities for deep holes	Effect of doubling wall thickness
Axial tensile load	$S_t \propto \rho \lambda C_W$	None
Vessel displacement or roll	$S_D \& S_R \propto \frac{\beta \sqrt{\rho \lambda EC_W}}{\sqrt{1 + (d/D)^2}}$	Decreases stress less than 4%
Ocean current drag force	$S_c \propto \frac{V^2 L}{D} \times \frac{\sqrt{E/\rho \lambda C_W}}{\sqrt{[1 - (d/D)^2][1 - (d/D)^4]}}$	Decreases stress less than 15%

This article was condensed from the paper "Pipe Stresses When Drilling from a Floating Vessel" presented at the Petroleum Mechanical Engineering Conference, New Orleans, La., September 18-21, 1960, of The American Society of Mechanical Engineers.

SYMBOLS USED

A — Cross sectional area of pipe, casing, or kelly being considered.
C — Correction coefficients.
C_q — Ocean drag coefficient = 1.2 for long cylinder.
C_w — Ratio weight per foot of tubing with couplings and/or joints vs weight per foot of plain tubing.
D — Outside diameter of pipe or casing.
d — Inside diameter of pipe or casing.
E — Modulus of elasticity.
F — Height of tower (crown block to rotary table).
H — Length of kelley, pipe, or casing above table.
H′ — Length of kelly, pipe, or casing above table in feet.
I — Moment of inertia of member being considered.
J — Polar moment of inertia of member being considered.
L — Distance from ocean floor to rotary table (approximately the water depth).
L′ — Water depth in feet.
P — Weight of pipe or casing.
Q — Force per unit length due to current (include the Magnus effect when drilling).
R — Radius of pipe, casing, or kelly being considered.
S — Stress in member considered.
T — Torque due to rotation force of the rotary table.
t — Wall thickness of pipe or casing.

$$U = \sqrt{\frac{PL^2}{EI}} \quad U_h = \sqrt{\frac{P_h H^2}{EI_h}} \quad U_l = \sqrt{\frac{P_l L^2}{EI_m}} \quad U_m = \sqrt{\frac{P_h L^2}{EI_m}}$$

V — Ocean velocity.
V_k — Ocean velocity in knots.
W — Weight per unit length of pipe or casing.
Y — Horizontal distance the ship is displaced from directly over the hole.
Z — Section modulus of pipe, casing, or kelly being considered.
β — Angular deflection (equals Y/L and at top add Θ).
λ — Depth of hole.
λ' — Depth of hole in feet.
ρ — Density of tubing in water.
ρ_p — Density of tubing (0.284 lb/cu in. for steel).
ρ_w — Density of sea water (0.037 lb/cu in.).
Θ — Roll of ship (Radians).
$\Theta°$ — Roll of ship (degrees).

SUBSCRIPTS

C — Conditions due to ocean current drag force.
D — Conditions due to displacement of vessel from over the hole.
h — Conditions at table.
l — Conditions at ocean floor.
m — Conditions between ocean floor and ship.
R — Conditions due to roll of vessel.
s — Shear stress.
t — Tensile stress.
Σt — Combined tensile stresses.

For formulas used throughout report, all units are in inches and pounds unless specified otherwise.

About The Author

Edward R. Lind obtained his M.S. degree at Oregon State College in 1947, having majored in mechanical engineering and electrical engineering. Since graduation he has been employed by Standard Oil Company of California, except for three years (1951 to 1954) with California Research and Development Company. At California Research and Development Company he was a high vacuum specialist and project engineer in the mechanical laboratory and electronic control laboratory. At SOCAL his assignments have been in the Engineering Department and include being instrumentation and control specialist, chemical plant designer, project engineer for offshore drilling problems, a heat transfer specialist. Currently, he is working for California Research Corporation in La Habra, Calif.

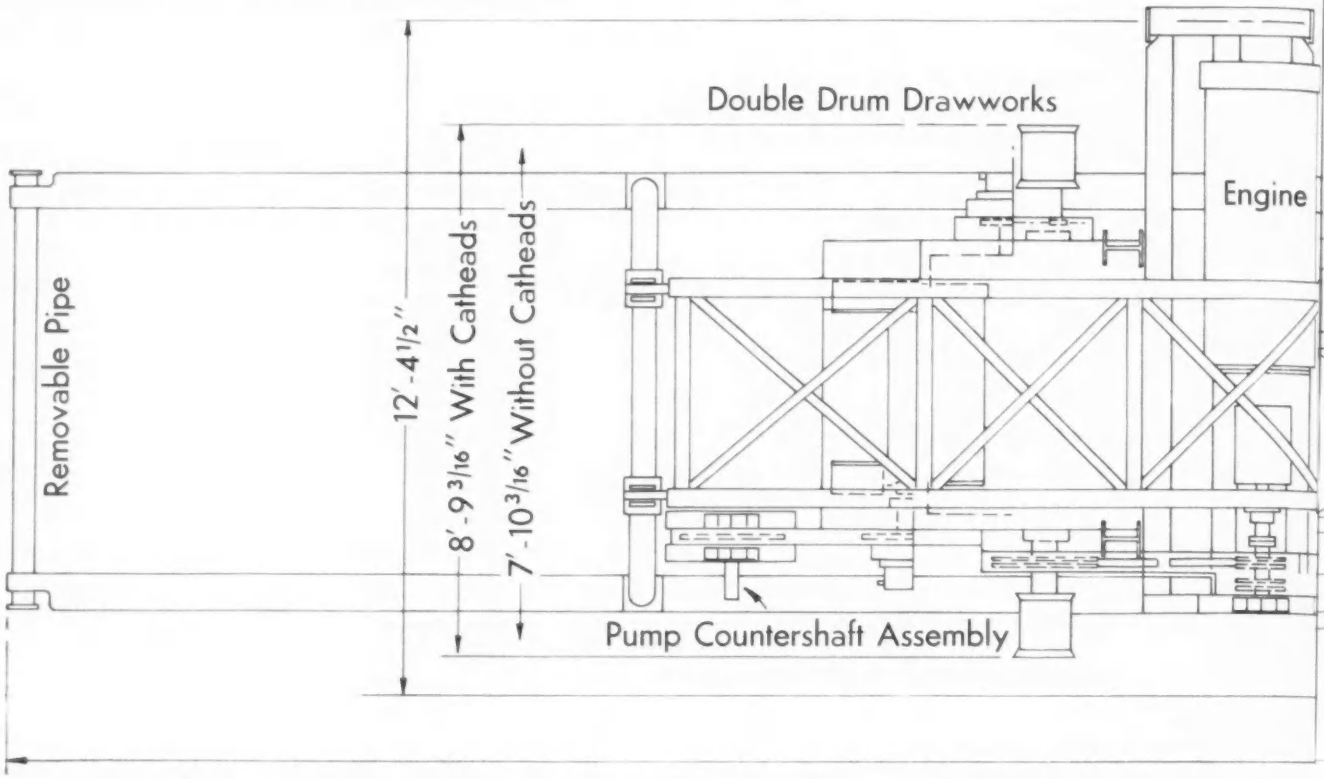


FIGURE 1—Engineering drawing shows rig in detail. Pump countershaft assembly in front of drawworks can be used for extra pump or single pump if No. 2 engine and tank are removed from main skid. Note that No. 2 engine, pump and slurry tank are mounted on separate skid installed crosswise on main rig skid.

New concentric tubing workover rig cuts remedial costs offshore

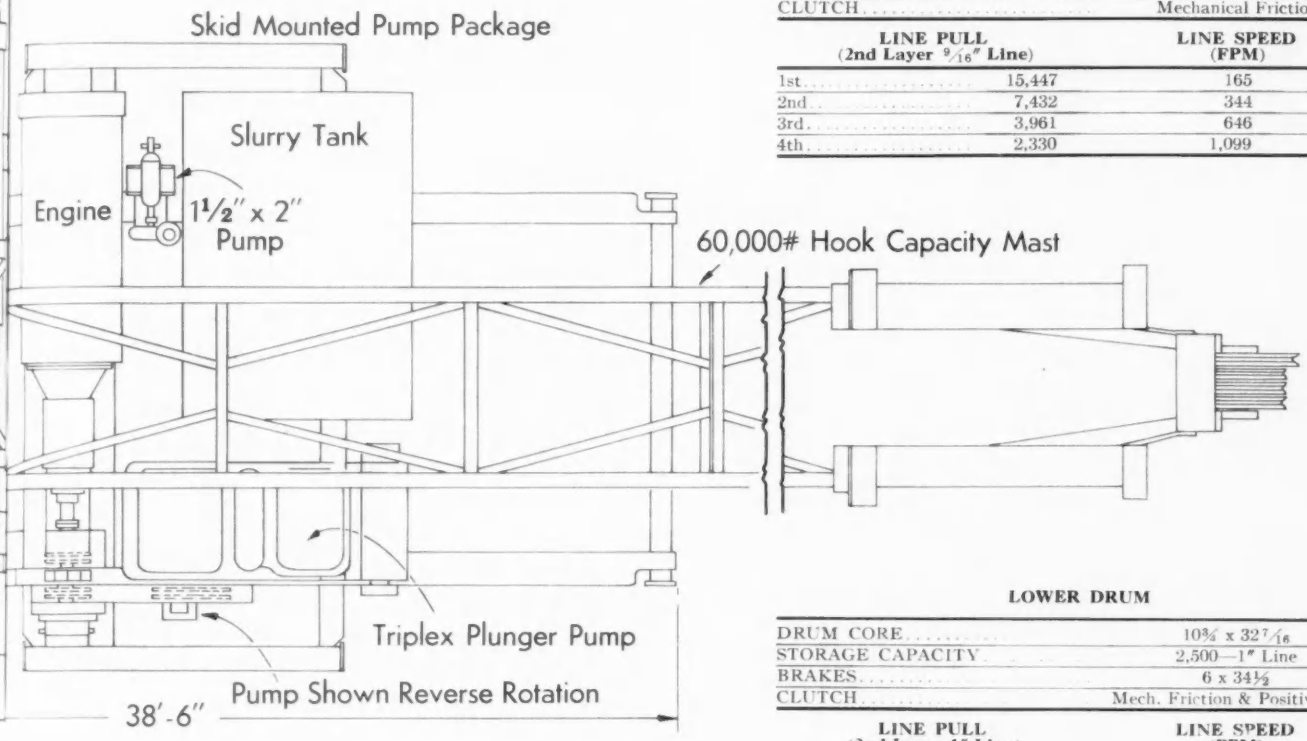
Unit is self contained, can operate on 15 x 20 foot well guard type platforms with up to 15,000 feet of pipe racked in the derrick

R. W. Scott
Engineering Editor
WORLD OIL

A NEW, COMPLETELY SKID MOUNTED, concentric tubing workover rig designed especially for offshore use on small well protector type platforms recently was put into service by Williams Drilling Company of Baton Rouge, La. The rig has been initially installed on a barge hull and is currently being used for operations in shallow water areas. Chief advantages of the new unit, which operates on a 24 hour basis, are:

- Fits on offshore well platforms as small as 15 x 20 feet.
- Can be installed on an offshore platform in a single lift with a small derrick barge because of its light weight (32,000 pounds).
- Is completely equipped with double drum drawworks, hydraulic rotary table, twin diesel engines, triplex plunger pump, slurry tank, etc.
- Is capable of operating as a single or twin-engine unit. If used as single engine-rig, the triplex plunger pump is repositioned beside the drawworks.
- Has removable mast section which can convert 53-foot singles mast to 87-foot mast capable of handling doubles.
- Can operate on platforms with up to 15,000 feet of 1 5/16-inch OD, 1.8 pound per foot tubing racked in the derrick.

Development of the new rig resulted from the success of the concentric tubing workover method originated by Gulf Oil Corporation in 1956-57 (See WORLD OIL, March 1958, Page 135). Because of economics, the concentric tubing method now is used whenever possible by most marine operators in South Louisiana. To date, the technique has been used to wash sand from tubing and casing, drill out scale deposits in tubing, perform squeeze and plug-back jobs, run small OD screen liners, perform sand



UPPER DRUM

DRUM CORE	10¾ x 42
STORAGE CAPACITY	10,250'—9/16" Line
BRAKES	6 x 34½
CLUTCH	Mechanical Friction

LINE PULL (2nd Layer 9/16" Line)		LINE SPEED (FPM)
1st	15,447	165
2nd	7,432	344
3rd	3,961	646
4th	2,330	1,099

LOWER DRUM

DRUM CORE	10¾ x 32 7/16
STORAGE CAPACITY	2,500—1" Line
BRAKES	6 x 34½
CLUTCH	Mech. Friction & Positive Jaw

LINE PULL (2nd Layer 1" Line)		LINE SPEED (FPM)
1st	20,817	122
2nd	10,016	255
3rd	5,337	479
4th	3,139	815

PUMP

JACKSHAFT RPM	295
TRANSMISSION SPEED	3rd
H.P.	85

consolidation jobs, drill out excess cement fill-up in casing, etc.

Since the concentric tubing workover method was introduced, several conventional workover units have been adapted to use small OD pipe for through-tubing work. However, Williams' new rig is one of the first known to have been designed especially for use on very small off-

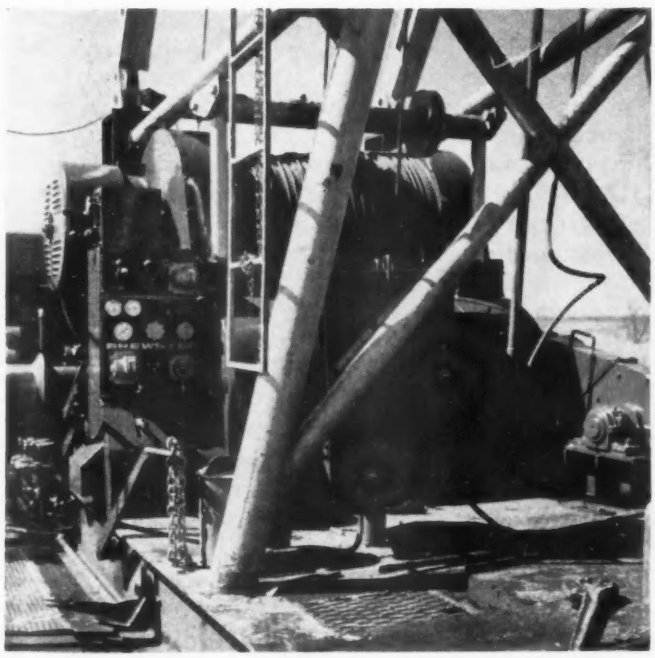


FIGURE 2—Double drum drawworks has four forward speeds, one reverse. Both drums are equipped with twin disc air and positive jaw clutches. Pump countershaft is visible at extreme right of photo.

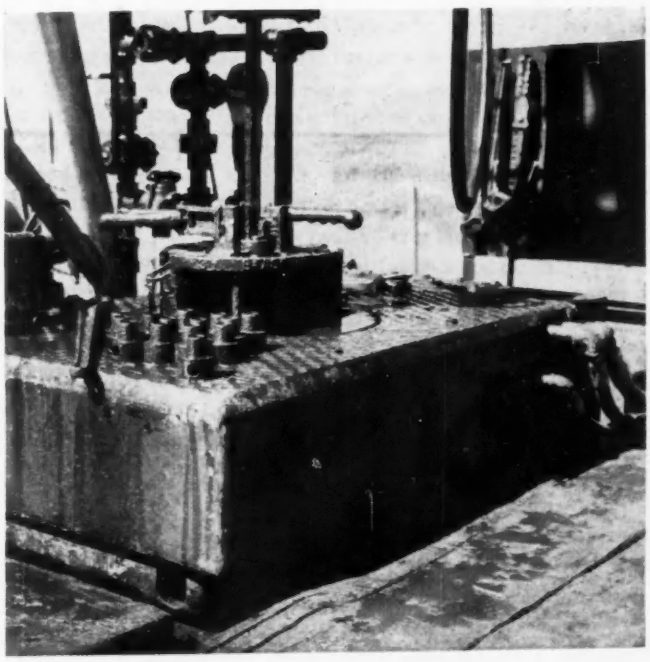


FIGURE 3—Rotary is powered by two hydraulic motors actuated through a hydraulic system which operates off of the No. 1 engine. Hydraulic system also powers tubing tongs.

FIGURE 4—Rig is mounted on six foot substructure set on top of eight foot subbase. Small tank on right of derrick floor contains hydraulic fluid for BOP hand pump operation. Note clearance between well guard and floor.

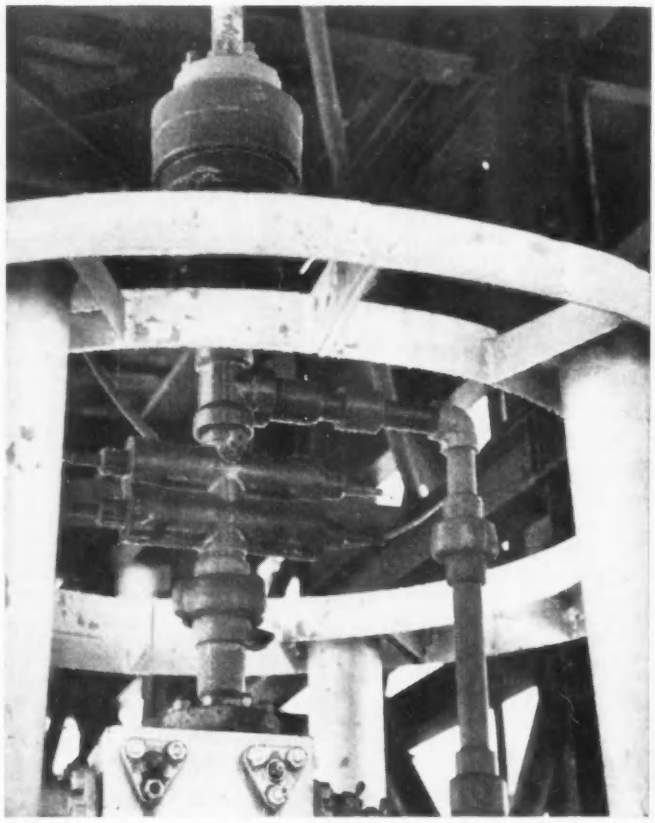


FIGURE 5—Blowout preventer hookup consists of single bag type and dual ram type preventers. Bag type preventer is actuated hydraulically by a hand pump on the derrick floor while ram type preventers are manually operated.

shore well guard type platforms. The final design resulted from conferences between Williams' personnel, offshore operators and the manufacturer.

The complete rig is mounted on a single 38½ foot x 8-foot skid as shown in Figure 1. As mentioned previously, a removable section permits use of either a 52 foot 11½-inch "singles" mast or an 87-foot "doubles" mast. Hook capacity of the telescoping mast is 60,000 pounds.

The custom-built double drum drawworks is equipped with a pump countershaft on the off-driller's side in lieu of a rotary drive (Figures 1 and 2). The pump shaft assembly is used if the operator desires to install an additional pump or move the rear mounted triplex to the forward position. The top view of Figure 7 shows two pumps installed.

Power is furnished by twin six-cylinder, 115-horsepower diesel engines. As indicated in Figure 1, power units are compounded, with one engine normally used on the drawworks and one on the triplex plunger pump. However, both may be used for a single operation, if necessary.

The rig is basically a single engine unit, but two engines are used if the operator desires a safety factor. The accompanying photographs and drawing show two engines used in all cases.

Referring to Figure 1, engine No. 2, the 40-barrel slurry tank and the triplex pump are integrally mounted on a skid installed crosswise on the main rig skid. Removal of this "pump package" converts the rig to a single engine unit. In this case, the pump is removed from the package and mounted beside the drawworks as mentioned previously.

One of the more unique features of the rig is the hydraulic rotary table which is powered by twin hydraulic motors (Figure 3). A complete hydraulic system operates off the No. 1 engine and provides power for both the rotary and the hydraulic tubing tongs. Storage for hydraulic fluid is built into the main rig skid.

The rotary is especially useful when the small tubing is used to drill cement, hard sand, etc. In the past, most operators have used power tubing tongs for this purpose. A 1⅜-inch OD. 24½-foot kelly is used in conjunction with the 2⅜-inch swivel shown in Figure 4. Flexible hydraulic hose connections and jack screws permit precise adjustment of the rotary table with relation to the well.

A single bag-type blowout preventer and a double 2½-inch ram type preventer are utilized for complete well control at all times (Figure 5). The bag-type preventer is actuated by a hydraulic hand pump located on the derrick floor. The cylindrical tank shown on the right hand corner of the derrick floor in Figure 4 contains hydraulic fluid for the hand pump. Ram-type preventers are manually operated.

Figure 6 shows the rig installed on a barge hull for use in shallow marine operations. The main skid is mounted on a 6 foot x 42-foot substructure which, in turn, rests on an 8-foot subbase. As indicated, this provides ade-

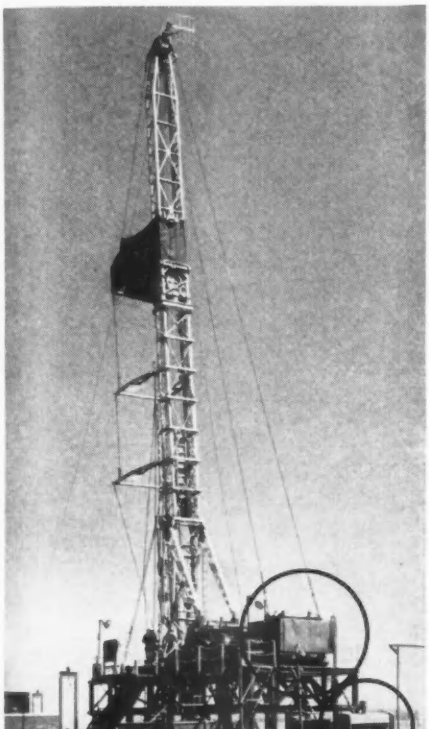


FIGURE 6—Rig is shown here mounted on a barge hull for shallow water operations. Note skid mounted pump package, slurry tank on barge deck and fuel tank on rig skid.

quate clearance between the well guard and derrick floor.

Use of the six-foot substructure is optional when the rig is operated on small platforms. However, it is used to advantage if the rig is to be installed on larger 30 or 40-foot offshore structures.

An additional triplex pump package and mud tank are installed on the barge deck when the rig is utilized in shallow water operations, and serve only as a safety factor. The deck pump also is skid mounted with a slurry tank and diesel engine (Figure 6).

Living quarters, generator house and fuel tanks are mounted on the barge at the end of the pipe rack.

Figure 7 shows how the rig will be used on small offshore well guard-type platforms. The complete rig with pump or pumps, additional fuel tank and slurry tank can be installed on 15 x 20-foot platforms equipped with a short deck extension and braces. If the operator desires, two engines and two pumps may be utilized on the platform as shown in the top view of

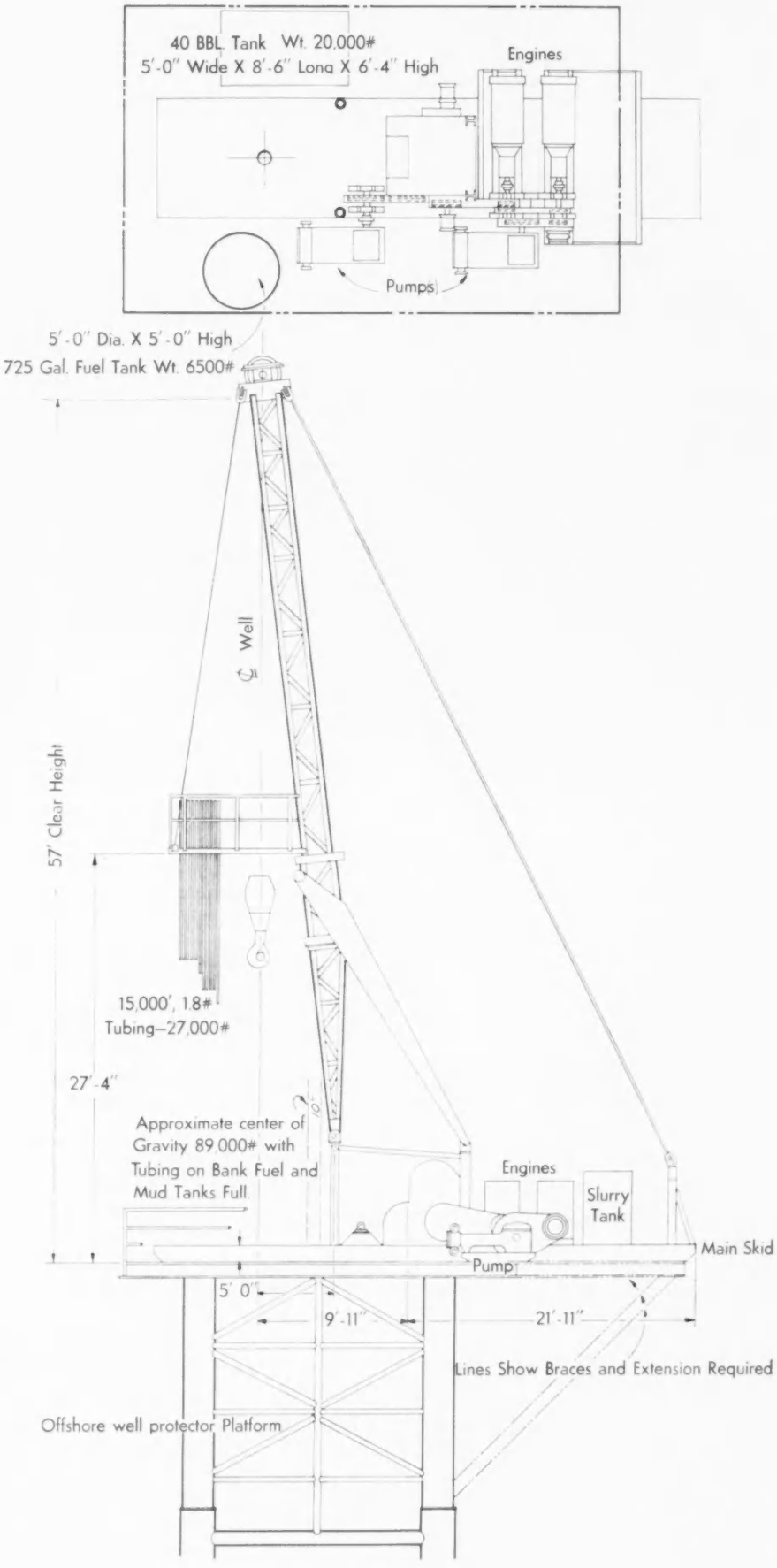


FIGURE 7—Rig can be installed on small offshore well protector platforms as shown. Note center of gravity even when both engines are utilized. Top view shows how two pumps may be installed on offshore locations.

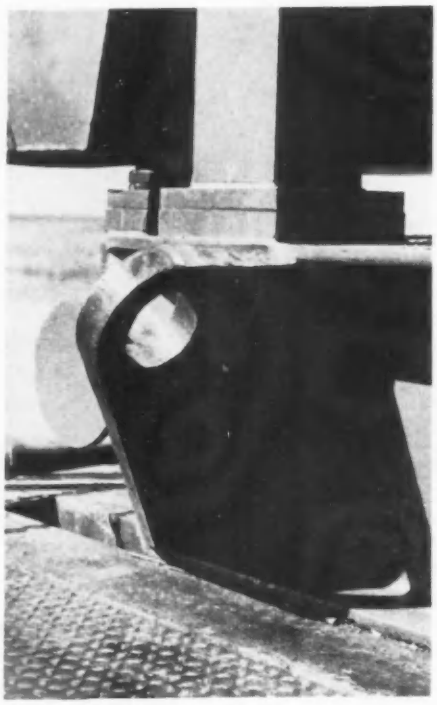


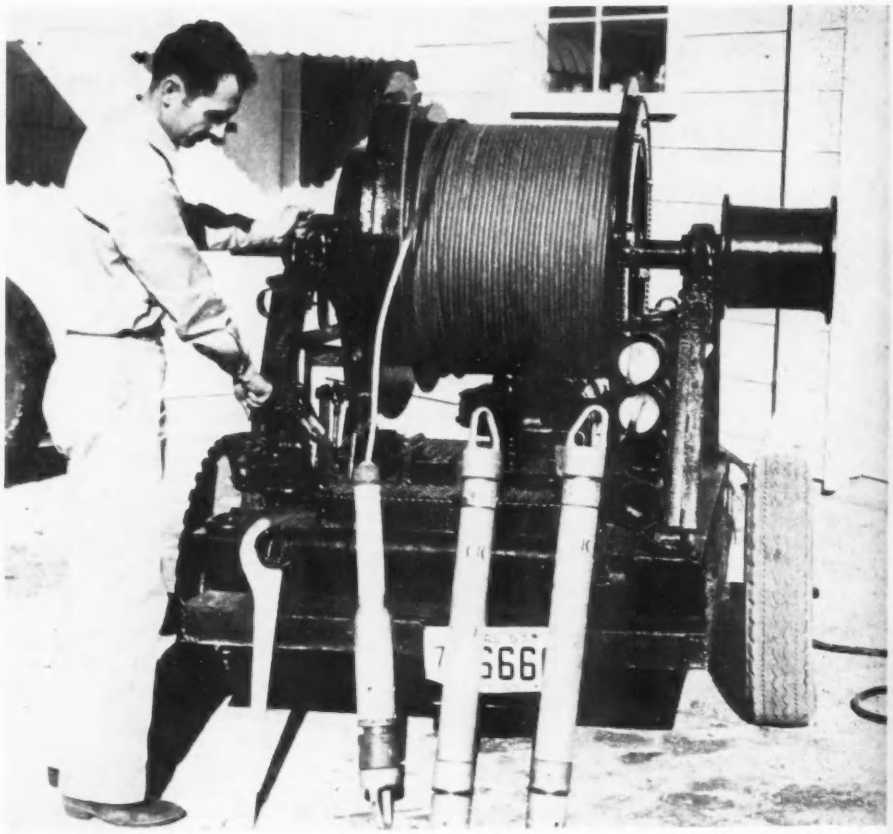
FIGURE 8—Lift "eyes" are provided on each corner of the main skid. Complete rig can be installed on platform with single lift by small derrick barge.

Figure 7. If one pump is considered sufficient for the job, it is repositioned either at the forward pump shaft or opposite the No. 1 engine as indicated in the side view of Figure 7.

Rig design is such that up to 15,000 feet of 1 5/16-inch OD tubing can be handled safely in the derrick on a platform location. The resulting center of gravity with this quantity of pipe racked is indicated in Figure 7. However, pipe can be hung over the side of the platform if the operator wishes.

Since total weight of the rig is only about 32,000 pounds, a small derrick barge can easily install the complete unit on an offshore platform in a single "lift". To facilitate operations of this type, lifting "eyes" have been provided at each corner of the main rig skid (Figure 8).

The new rig has fulfilled expectations of both contractor and operators, so far. For example, sand washing jobs have been conducted as deep as 14,000 feet in only eight hours and even more quickly at shallower depths. In fact, it is not unusual for the rig to work on as many as three wells on three separate locations in a single 24 hour period. —**The End**



More recent modification of an older system of determining the configuration (particularly in the case of overhangs) of salt domes provides for running two geophones in deep wells, with one jug at the bottom of the hole and the other up the hole 500 or 1,000 feet. Geophones, interconnecting cable, weights and other attendant equipment are carried on a trailer-mounted reel operated by hydraulic motors. Power is furnished by an electric motor suitable for connection to electric power supply on the rig. For offshore work, the reel assembly shown is simply slid off the trailer, transferred to a boat and delivered to the rig.

Salt dome refraction survey aided by double-jug layout

A WIDELY-USED TECHNIQUE of placing a geophone at the bottom of a deep well and mapping salt dome flanks by measurement of transit time of seismic impulses from surface shots[1,2,3] has more recently undergone certain improvements. Shots are detonated as much as five miles distant from the well in which the geophone is placed. The shock wave of greatest interest arrives at the geophone in the well in a nearly horizontal direction, hence the geophone is provided with two horizontal elements in addition to the conventional vertical element. Such geophones are capable of withstanding about 17,000 psi pressure and temperatures up to 300°F.

More recent modifications of this technique provide for installing a second geophone in the well, either 500 or 1,000 feet above the first. Both geophones operate simultaneously. The difference in arrival time at the two geophones measures the angle at which the wave arrives at the well and hence identifies in elevation the point of entry into the salt dome. Use of two "jugs" also reduces the number of shots required.

This method is particularly useful in offshore work to determine the configuration of overhangs in a salt dome, and relies essentially on a strong velocity contrast between a shale-sand section surrounding the salt and seismic velocity in the salt. Changes in mineralization can cause complicated velocity problems, even on different flanks of the same salt domes.

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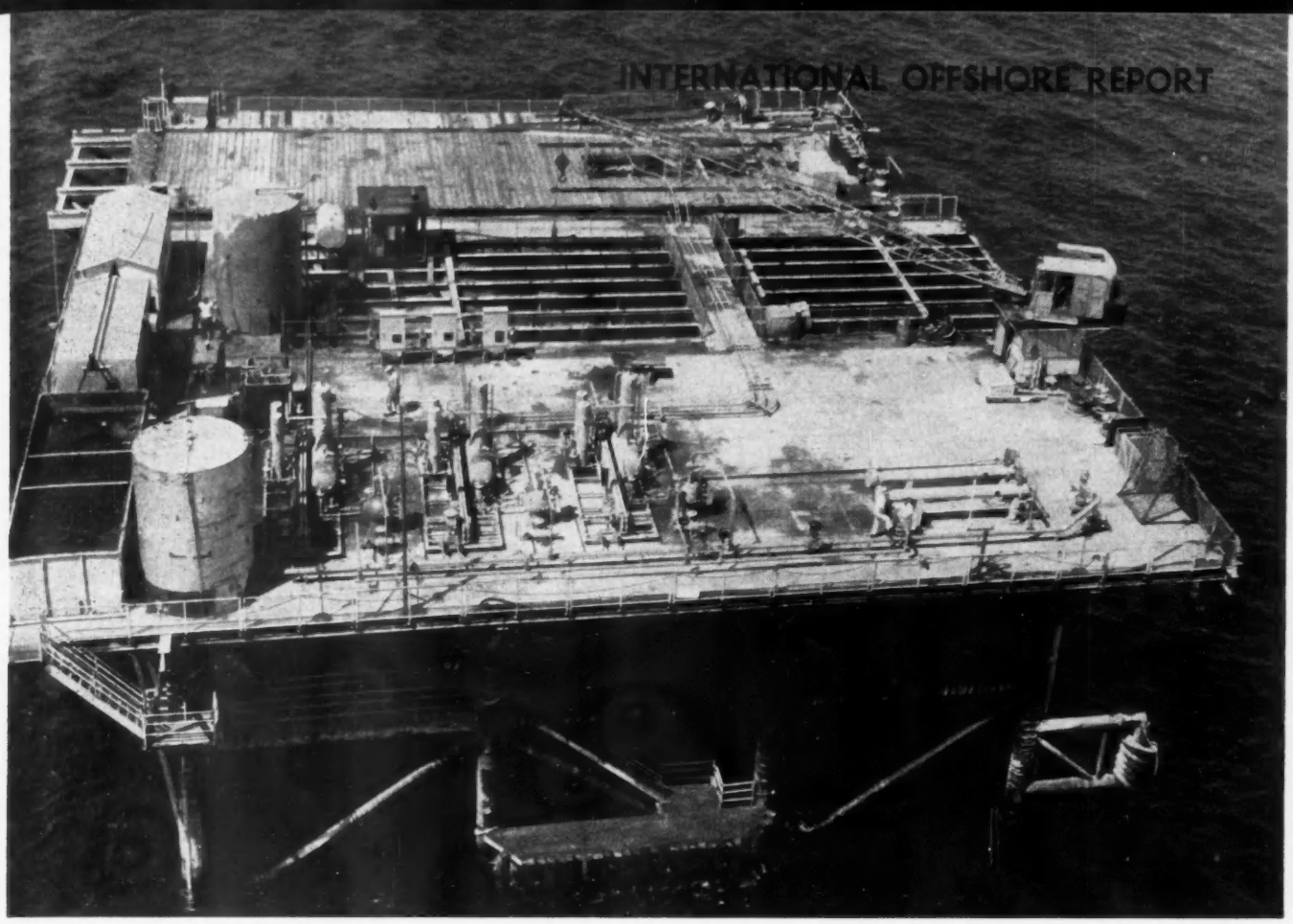
3 Musgrave, A. W., Woolley, W. C., and Gray, H., "Outlining of Salt Masses by Refraction Methods," *Geophysics* 25, No. 1, 141-167 (1960).



Aerial view shows layout of platform. Low temperature units and PV meters (spherical vessels) are at lower left, coalescing filters at lower right. Wells are located in rectangular "cellar" at upper right.

How to operate offshore production by remote control

New Gulf Oil automation project is completely unattended. Submarine cable between platform and shore transmits all control functions, signals and process data

By Sam H. Miller, District Engineer, Gulf Oil Corporation, Houston and
Allen C. Bradham, Project Manager, Texas Instruments, Incorporated, Houston

GULF OIL CORPORATION has installed a unique supervisory control and data telemetering system for three high-pressure gas-condensate wells located in Block 889 near Mustang Island, Texas, in the Gulf of Mexico. Automatic instrumentation provides for control functions; measurement of production variables; alarms and monitoring; and platform security.

The system control point is located on the bay side of Mustang Island at the onshore separation and storage facilities. All control functions, signals and process data are transmitted over a single pair of wires through a submarine electric cable between the offshore platform and the onshore control station.

The automatic system has resulted in a net savings of $4.852 per month as compared to manned operations.

PLANNING

A study was made of the various manual and automatic production systems capable of handling the three wells. Basic factors considered were cost, economics of operation, Coast Guard requirements, lost time or closed-in time attributed to weather conditions and safety, and reliability. The following basic premises were known or assumed:

1. Gas purchaser would lay pipe line from platform to shore.

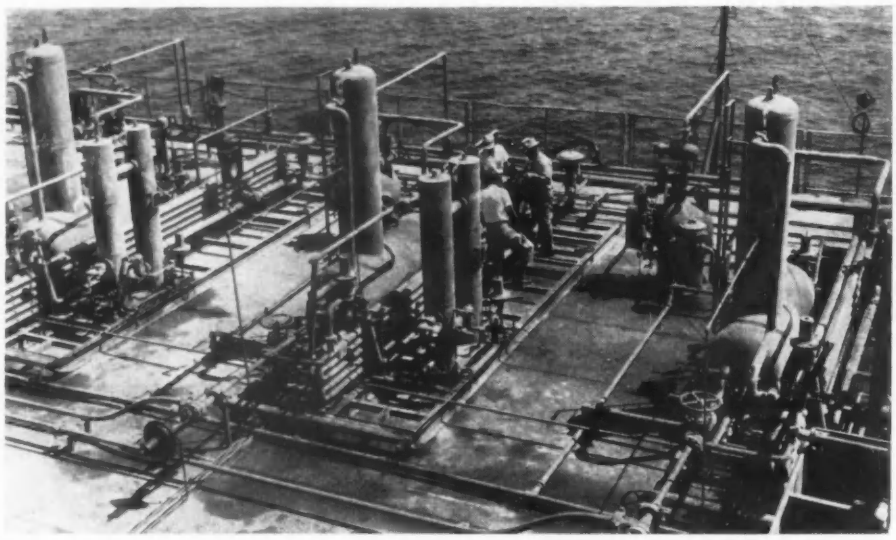


FIGURE 1—Primary producing equipment consists of three low temperature separation units. Operation is completely remote controlled from the onshore station.

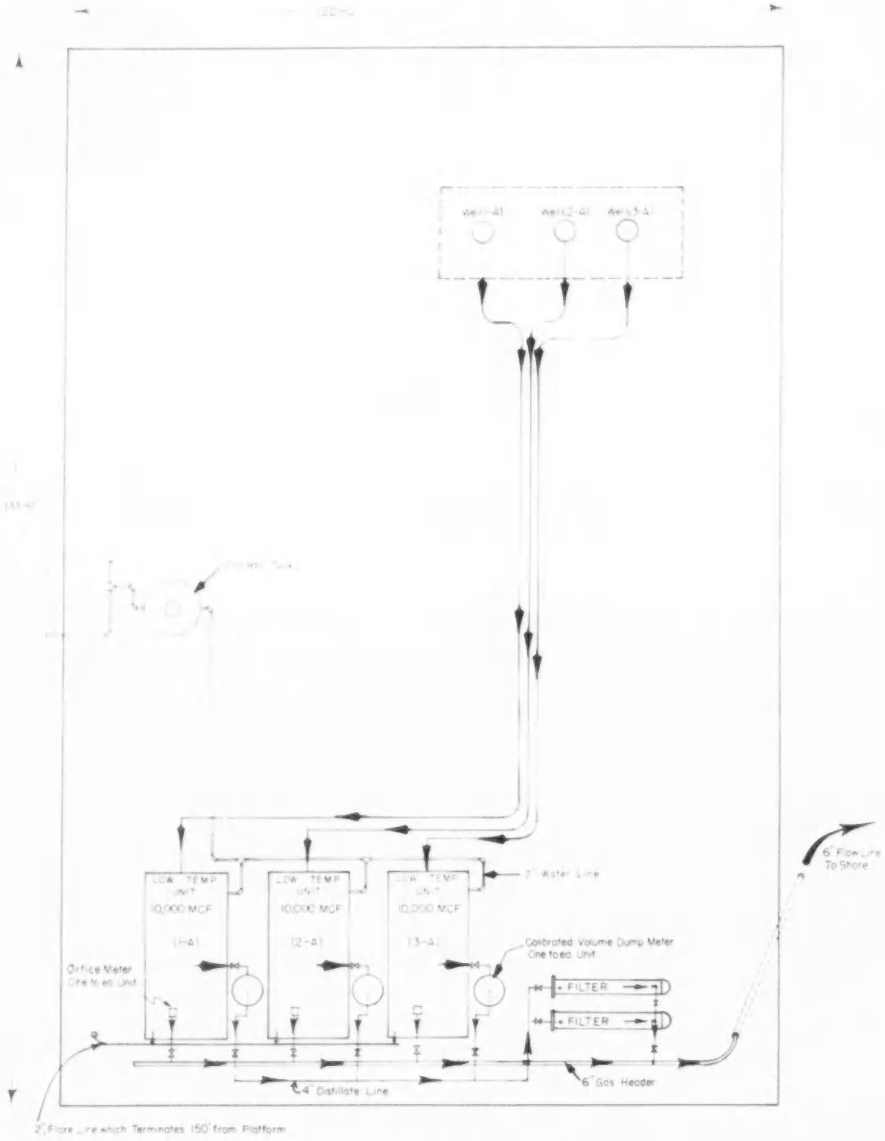

Well #1
Well #2
Well #3
LOW TEMP. UNIT 10,000 MCF (1-A)
LOW TEMP. UNIT 10,000 MCF (2-A)
LOW TEMP. UNIT 10,000 MCF (3-A)
2" Water Line
6" Flow Line To Shore
Calibrated Volume Dump Meter One to ea. Unit
Orifice Meter One to ea. Unit
FILTER
FILTER
6" Gas Header
4" Distillate Line
2" Flare Line which Terminates 150' from Platform

FIGURE 2—Platform flow diagram shows producing equipment hookup. Condensate and gas are recombined into common line after measurement.

2. Line would transport mixed stream of gas and liquids.

3. Maximum volumes of gas and liquid produced per day.

4. Variation of percent ownership in the three wells made it necessary to provide individual well volume measurements of gas and liquid prior to commingling into common stream for transmission to shore.

5. Transmission of the common stream through 3½ miles of line emersed in the Gulf of Mexico would reduce stream temperature to approximately that of the Gulf water. Data from the Department of Oceanography, Texas A. & M. College, indicated mean water temperature during the winter months would be approximately 60° F, which was below the hydrate-expectant temperature of 68° F at 1,000 psi. Therefore, the produced product (gas-condensate) would require dehydration at the platform.

From the preceding, three modes of operation evolved:

1. Liquid storage at a manned platform.

2. Liquid storage onshore with manned platform.

3. Liquid storage onshore without manned platform but monitored and controlled from an onshore station.

The last method appeared best, provided the full scope of such an operation could be achieved. Operation of producing equipment by remote control had not been accomplished successfully at that time according to available information. In effect, Gulf was faced with combining many components of automation into a system of supervisory control and data telemetering.

Basic factors considered in selecting a communication carrier were:

- Initial cost.
- Continuity of service.
- Operating and maintenance cost.

After careful study, the submarine cable was selected as the carrier medium for this particular project.

Producing operation. Producing equipment located on the platform consists of a low temperature processing unit for each well (Figure 1). Individual well production flows to the unit which removes free water, and separates and measures the produced gas volume and water free liquid volumes. A flow diagram is shown in Figure 2.

An orifice meter installed on each low temperature unit measures the gas volume before it is combined in a 6-inch header. The condensate is measured by a positive volume meter installed at each unit. The meter is designed to permit measurement between three closed valves in a vessel of precisely known volume.

After leaving the meters, condensate is combined in a 4-inch header and directed to coalescing filters for further extraction of water. From the filters, it enters the 6-inch header where it is commingled with the gas volume. The combined stream then is transported to shore through a 6⅝-inch OD flowline. Onshore, the stream is again separated with the gas being measured by means of an orifice meter before going to sales. Condensate is stored in stock tanks (Figure 3).

Water removed by the low temperature units is discharged through a common flowline to a siphon-equipped 210-barrel tank. This permits continuous water removal while maintaining a constant fluid level in the tank.

The automation system provides control and supervision for four basic functions:

1. Valve control to place a well into or out of production

2. Adjustable choke to regulate flow rate

3. Temperature control of the production unit

4. Corrosion inhibitor injection pump operation.

Figure 4 indicates the routing of the signals of the automation system. In performing a typical control action, such as opening a well head control valve or starting the chemical pump, the operator first causes a transfer of signal routing within the control equipment by depressing an interlock switch on the control console (Figure 5). When the operator dials, interrogation pulses are transmitted through the Transfer Unit, the Receiver-Transmitter Unit and the Input/Output Network over the telemetering line to the offshore terminal equipment. The dialing pulses are received by the Field Selector Unit which steps in accordance with the dialing pulses to select a command relay in the Power Matrix Unit representing the control valve or pump function to be actuated.

After it has made the proper point selection, the Field Selector Unit automatically transmits a point identification code train over the same telemetering line to shore. The point identification signals are received by the Receiver-Transmitter Unit and are routed through the Transfer Unit to the Data Memory and Digital Data Display Panel where the selected command point is displayed for the operator's verification.

After the operator confirms that he has selected the correct command point, he presses a Proceed Button which causes a signal to be sent over the telemetering line operating the power matrix relay and executing control action. Next, the operator releases the interlock switch causing the Transfer Unit to route subsequent signals to the Status Memory and Status Display Panel.

When control action is executed, the status of the pump or valve operated changes. This change is detected by the Status Scan Unit on the platform which scans all platform status points and transmits a digital code train defining platform status. The status code train is received by the Receiver-Transmitter Unit and is routed through the Transfer Unit to the Status Memory Unit where the information is stored. Information stored in the Status Memory is immediately displayed for the operator's use on the Status Display Panel.

The report of the platform status completes the control action "loop". The operator has executed the control action, the equipment on the platform has assumed the commanded position

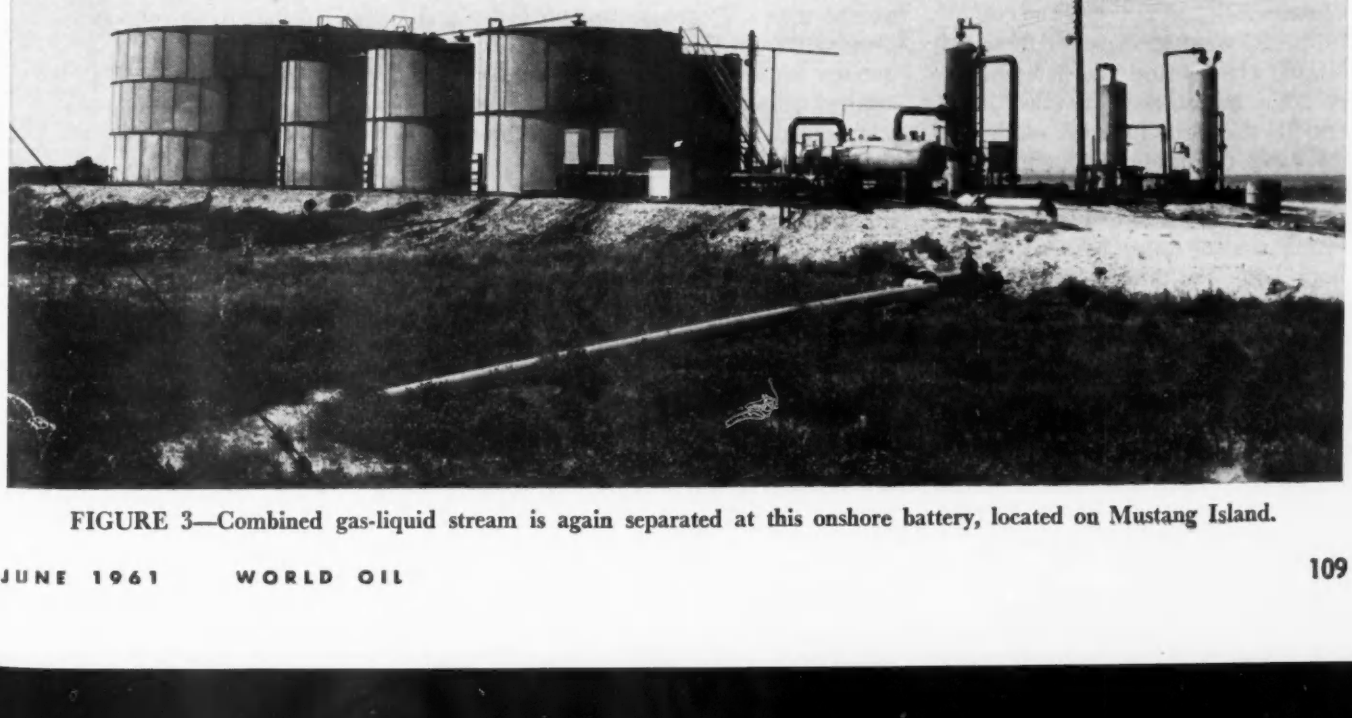


FIGURE 3—Combined gas-liquid stream is again separated at this onshore battery, located on Mustang Island.

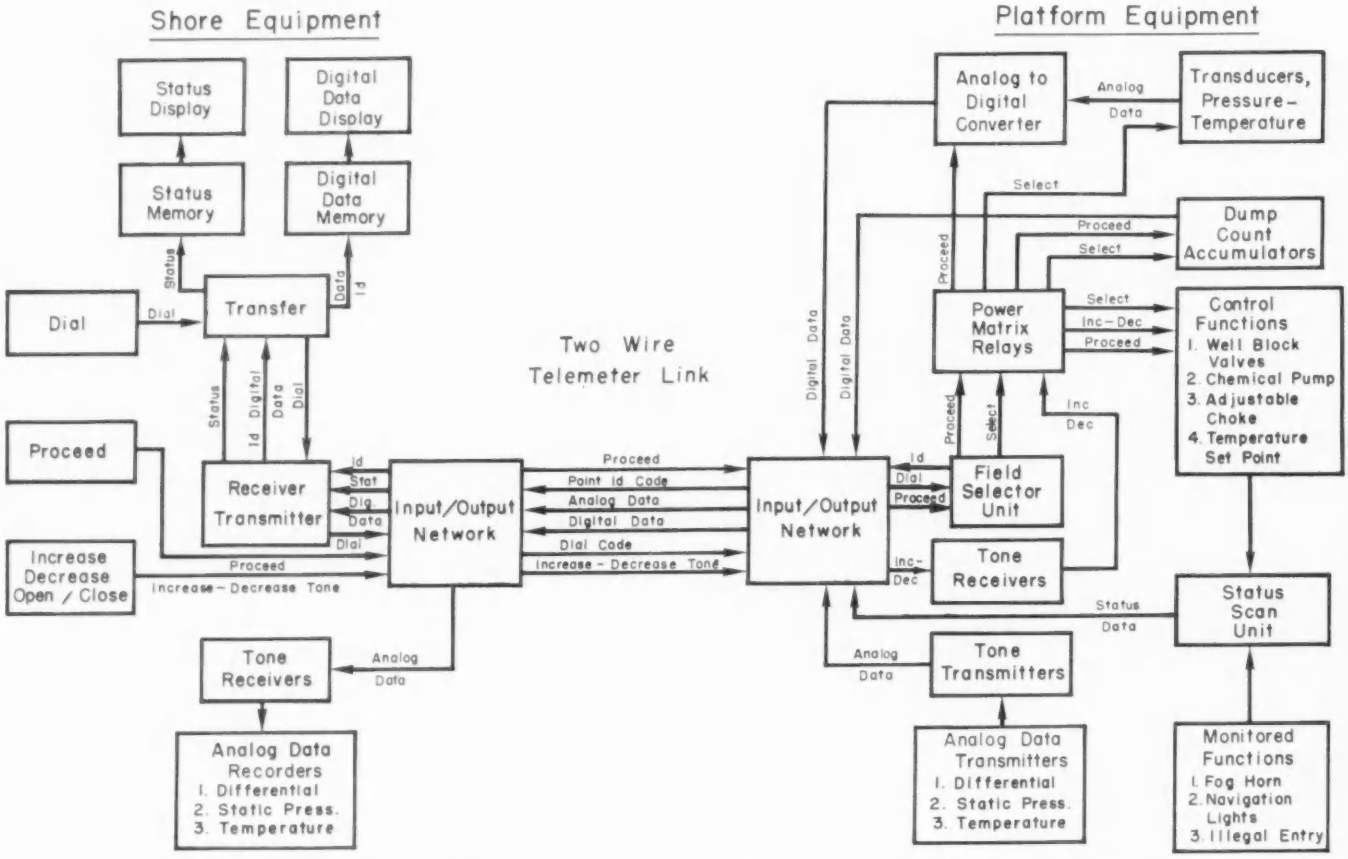


FIGURE 4—This schematic drawing shows complete signal routing for the automation system.

and the new status of the equipment has been displayed assuring the operator that his command has been obeyed.

Design of the Status Scan system is such that status changes are reported automatically as they occur. The Status Scan Unit transmits only after changes in equipment position, thereby requiring that the Status Scan Unit operate only when necessary. However, platform status can be interrogated by the operator by merely dialing a command number and requesting a scan of all platform status points.

Operation of devices such as adjustable chokes and the temperature set point adjustors is handled in essentially the same manner as for control valve operation. Following point selection and identification, the operator presses an Increase or Decrease Button routing tone signals from the shore Tone Transmitter to the Power Matrix relay controlling the choke or set point adjustor motor.

To increase flow rate, the operator dials a number which selects the choke to be controlled. When point identification appears, the operator first presses the Proceed Button and then presses and holds down the Increase Button. While this button is down, an AC voltage (tone) of 1,075 cycles per second is applied to the transmission line.

At the platform, the signal is received by a tone receiver tuned to this frequency. The receiver closes a power matrix relay and applies power to the adjustable choke drive motor to open the choke. As long as the Increase Button is depressed, the motor will continue to run and open the choke.

When decreasing the production rate, the same procedure is followed except that a Decrease Button is depressed. When this occurs a tone frequency of 865 cycles per second is applied to the telemetering line and is received through a different tone receiver.

The adjustable choke requires approximately 12 minutes to run from full close to full open position. The operator must keep the directional operating button depressed to keep the valve in motion. Electric motors on the adjustable chokes have limit switches to prevent over-controlling. During flow rate adjustments the operator may watch the flow chart for the well being adjusted to insure setting the rate at the desired value.

The temperature controller set point adjuster is controlled in the same manner. During adjustment, the operator watches the second hand of the console clock knowing that the set point changes at a rate of 1 percent full scale per second of operation.

Measurement of process variables. To keep the operator informed as to the state of the production operation, important temperatures, pressures and flow rates are measured and transmitted to shore. The points of measurement, separate for each of the three wells, are as follows:

1. Wellhead pressure	0 - 10,000 psi
2. Flow line pressure	0 - 10,000 psi
3. Flow line temperature	0 - 200 °F
4. Cold zone temperature	0 - 200 °F
5. Freewater knockout temperature	0 - 200 °F
6. Gas temperature	0 - 100 °F
7. Gas measurement, static pressure	0 - 2,000 psi
8. Gas measurement, differential	0 - 100" H_2O
9. Condensate meter dump count accumulation	

Transducer elements for the previously listed telemetered functions are enclosed in explosion-proof housings. When it is desired to read any of the pressures or temperatures, the operator dials a transducer readout num-

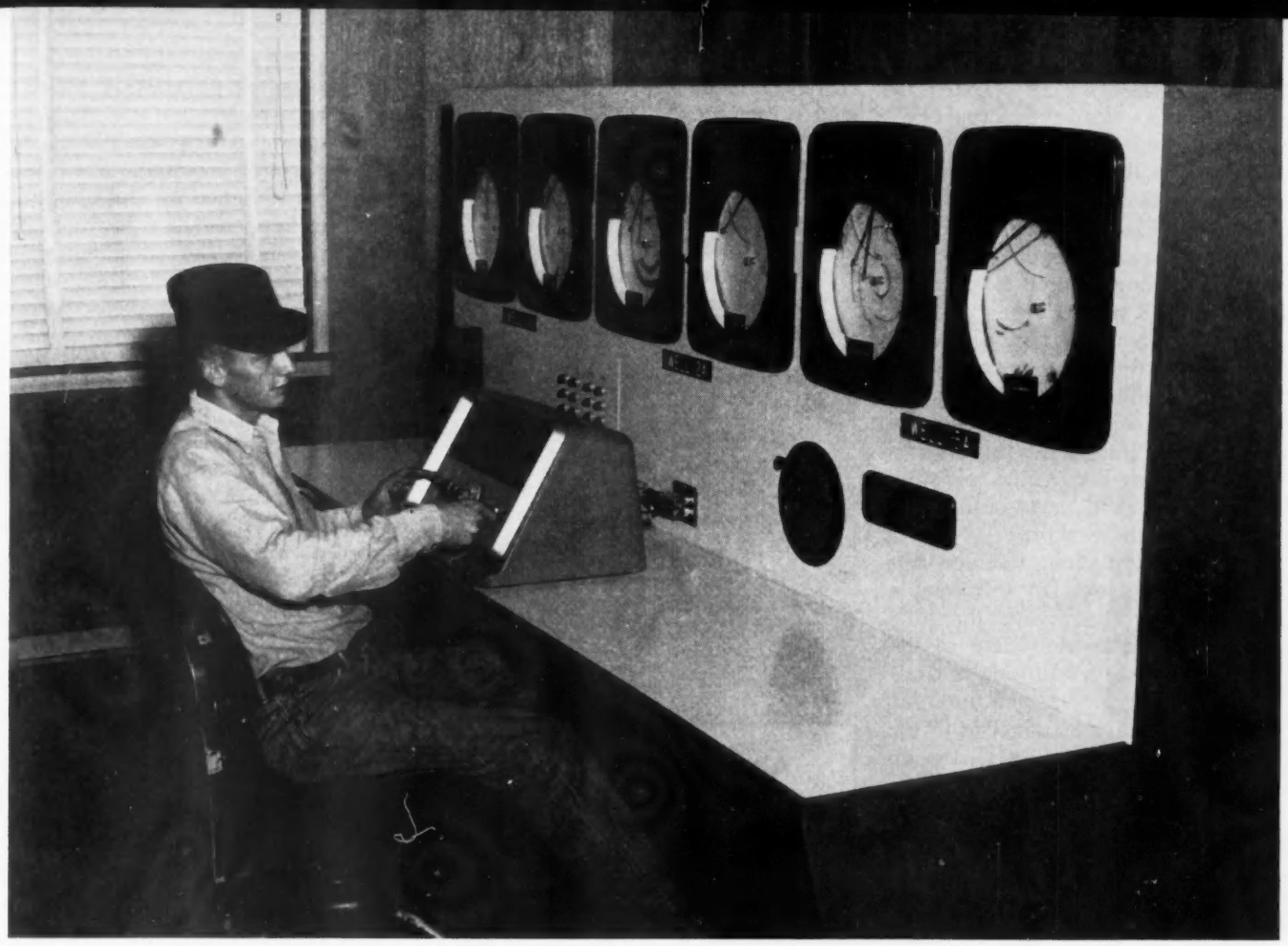


FIGURE 5—Onshore control console is equipped with temperature recorder and gas chart for each well.

ber and presses the Proceed Button as he would in executing a control command. Through this procedure, the Power Matrix Unit connects the transducer to the Analog-to-Digital Converter which balances against the resistance output of the transducer and transmits a digital code train to shore.

The data signals are received by the Receiver-Transmitter Unit and are routed through the Transfer Unit to the Data Memory where the information is decoded and stored prior to display. After decoding, all data is displayed visually for the operator to note or record.

The dump meter count accumulation is read in the same manner except that the Analog-to-Digital Converter is not required. Each of the three dump count accumulators has its own built-in scanner encoder which generates a digital code train defining the number of dumps stored in the accumulator. When read, the accumulator is selected by dialing. Readout then is initiated by depressing the Proceed Button. All dump count information is displayed visually for the operator's convenience.

In this automation system, six pressures and nine temperatures are available for digital readout upon interrogation by the operator.

Differential pressure, gas static pressure and gas temperature are treated as analog functions and are measured continuously. This information is transmitted to shore by means of tone transmitters keyed by time duration impulse transmitters which transmit signals proportional in time duration to the value of the measured variable.

The transmitted tones are mixed with the other information on the code line through a suitable input network such that digital code and analog tone signals do not affect each other during transmission. On shore, tone signals are filtered and routed to the proper tone receivers and recording instruments. The measured analog information is reproduced on circular paper charts. A separate tone channel is supplied for each of the nine analog variables.

Alarms and monitoring. Status indications of the following functions are necessary for the security of the platform:

1. Navigation lights
2. Foghorn
3. Illegal entry
4. Wellhead control valve
5. Chemical injection pump
6. Console temperature
7. Platform cubicle temperature

All of these points are connected to the Status Scan System to indicate the current status of each function. Indication is visually presented in terms of lights on the onshore console panel. A scan of all alarm points is initiated whenever any point experiences a change in status as previously stated.

Changes in status are indicated immediately except when the telemetering line is in use carrying other digital information. When the line becomes clear, the status scan system then reports any changes. Because of the ability of the system to "remember", no information is lost because the telemetering line happens to be in use.

Foghorn and navigation light monitor units are unique in that they represent a solid state approach toward the monitoring of these vari-

ables. The foghorn is detected by means of an "ear" (microphone) mounted on the side of the unit which is sensitive to the sound emitted. The horn generates sound for two seconds out of a 20 second interval. During the two second output interval, a timing circuit is charged. During the 18 second silent interval, the timing circuit discharges. In the event the horn fails to sound at the end of the normal silent interval, the timing circuit discharges beyond the normal safe limit and a transistor switching circuit is triggered initiating a status scan and transmitting the alarm condition to shore.

The navigation light monitor acts in a similar manner. In this case, a transformer in series with the bulb filament detects current flow to the bulb. In the event a bulb fails to draw current for the proper time interval, the timing circuit discharges as in the foghorn monitor and initiates an alarm.

The circuit is designed to work in conjunction with navigation lights using automatic bulb changer mechanisms. For this reason, timing circuits are arranged to allow the navigation lights time to change bulbs prior to sounding an alarm. If a navigation light fails to find a good bulb, an alarm is sounded telling the operator a service trip to the platform is necessary.

Illegal entry monitors are simply photoelecetric cells mounted at the entrances to the platform to indicate that unauthorized personnel have entered the platform. These units can be reset from the shore by dialing a command number. In case of emergency, personnel who have entered the platform may contact the shore control room by means of a telephone in the platform control house.

Terminal equipment. All equipment outside the platform control house is explosion-proof and is capable of withstanding severe marine atmospheric conditions. Equipment inside the control house is not explosion-proof.

All consoles and instrument enclosures are designed for a nitrogen purge system. Nitrogen gas first was used for reducing the moisture content inside the equipment. However, because of excessive cost this was later changed to dry air.

Equipment failures and remedies. To date, seven major failures have occurred both in electrical and mechanical equipment.

1. Paraffin in the produced gas stream was found to be plugging the sensing control elements as well as the pilot controls on the positive displacement meters. This condition was remedied by resorting to dry air for pilot energy rather than natural gas.

2. Difficulties were experienced in transmitting commands and information because of electrical equipment damage due to excessively high supply voltages. The problem was solved by installing constant voltage transformers both at the shore console and on the platform.

3. Occasionally, a well would be shut-in due to fuse failure on the platform. This was caused by sticking positive displacement meter contacts. As a result, a steady voltage was placed on the dump count accumulator circuits which were designed for pulse inputs. When this happened, a fuse would be blown shutting in the associated well. This condition was solved by redesigning the dump count accumulators to withstand a constant voltage input.

4. Control and data equipment, sometimes failed to operate when "requested." This difficulty was traced to faulty relays which ceased to function after a number of operations or when the temperature within the platform instrument cubicle reached a high level. The relays were found to be inadequate for the application and were replaced with a heavy duty type.

5. During winter months, it was found that the onshore separator would not dump properly and condensate would be discharged into the gas transmission line. This was caused by paraffin accumulation on the float. An indirect heater was installed on the inlet side of the separator and another separator was placed in series with the existing vessel. To date, no further difficulty has been encountered with the separator or with fluid entering the gas transmission line.

6. Occasionally, adjustable chokes failed to function. After each failure, the stem would be found broken and the seat fractured. It appears that the limit switches do not stop the electric motor at the same point each time. This problem is being worked out with the choke manufacturer.

7. The communication cable which extends from the onshore termination point of the submarine cable to the control house was buried to eliminate atmospheric corrosion of the messenger wire used to support it and the "dancing" caused by wind on the long spans. Gophers gnawed into the cable and caused failures in two of the three pairs of communication wires. Four separate insulated copper wires suspended on electric power line poles have been installed and should prevent recurrence of this problem.

Even though some difficulties have been experienced with the electrical and mechanical equipment, it is believed that the solutions provided to the problems experienced will afford trouble-free operation of the system as originally conceived. —**The End**

About the Authors

Miller Bradham

Sam H. Miller received a B.S. degree in petroleum engineering from the University of Oklahoma in 1946. He joined Gulf Oil Corporation as a petroleum engineer upon graduation and has served in various engineering jobs since that time. He has had extensive experience in drilling and producing operations in the Gulf Coast area. At present, he is District Engineer for Gulf's Houston Production District.

Allen C. Bradham was graduated from the Georgia Institute of Technology in 1950 with B.S. degree in mechanical engineering. He joined Penn Instruments Division of the Burgess Manning Company and worked as an instrument engineer, production engineer and chief engineer of the company. He was promoted to the position of chief engineer and production manager in 1958. He joined Texas Instruments in 1959 and was assigned to the Gulf Mustang system as project leader. At the present time, he is project manager for Texas Instruments.

High density packer fluids pay off in South Louisiana

Clean, particle-free brine solutions minimize formation damage during completion operations, simplify workover jobs

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E. D. Gould, Asst. District Engineer
Continental Oil Company, Harvey, La.

CONTINENTAL OIL COMPANY has had good success in using high density brine solutions (up to 14 ppg) as completion and packer fluids instead of the conventional mud system. There are two primary advantages in using salt brines:

- Use of a clean, particle-free medium minimizes formation damage during completion operations. (Perforations are cleaner, sand control plastic squeeze jobs are more successful, etc.)
- The fluids do not settle or solidify in the tubing-casing annulus and complicate workover jobs. Also, a reliable circulating fluid capable of retaining any formation pressures in the well is available at all times.

Experience has indicated that three basic systems are suitable for completion of packer fluids:

- NaCl—8.3 to 9.8 ppg
- $CaCl_2$—8.3 to 11.5 ppg
- $CaCl_2$-$ZnCl_2$—11.5 to 14.0 ppg

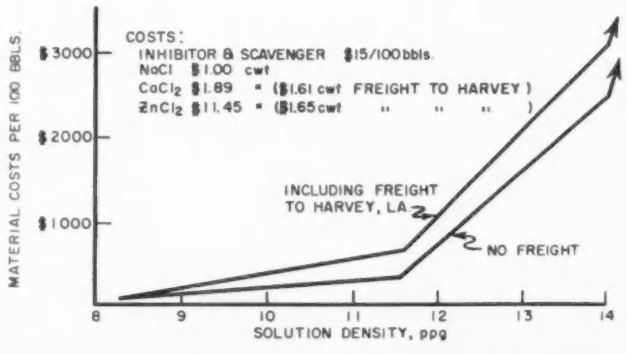

FIGURE 1—Approximate material costs for brines.

Proper use of these solutions will result in cleaner completions with fewer production problems. However, improper use will simply compound existing problems.

This article will discuss Continental Oil Company's use of dense brine solutions in the South Louisiana and offshore areas.

COMPLETION FLUIDS

A major problem in the South Louisiana-offshore area is sand production, and one technique for combating the sand flow is to squeeze plastic into the formation to consolidate the sand in place. Conventional drilling muds interfere with plastic squeezes[3] in the following ways.

1. Solids can form tough filter cakes on the face of the formation during perforation which would stop bore-to-formation flow.

2. Solids remaining in the bore can form a filter cake

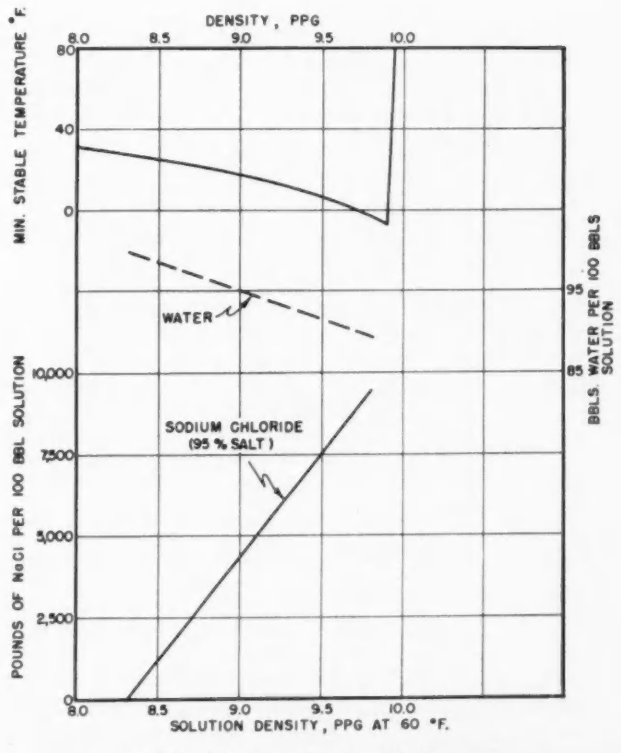

FIGURE 2—Mixing chart for NaCl solutions.

at some of the "open" perforations when the operator tries to squeeze plastic into the zone.

3. "Fines" can be carried along with the plastic and further reduce the residual permeability in the squeezed areas.

Particle-free brines eliminate these problems. Conoco has found that the use of brines with plastic squeezes offers the best working technique to combat sand-production problems in this area. Of 53 zones treated so far, two-thirds have had no sand production problems. Although these results are encouraging, there are obviously some problems and complications which prevent complete success or cause outright failures in one-third of the wells. It is usually impossible to define *the* cause of a failure, and frequently several factors are involved. Some which affect the brine are:

1. The importance of thoroughly cleaning the well bore was not realized, and some of the "clean" brines in early wells were contaminated with mud solids. Thorough flushing with sea water is now routine.

2. If the plastic and brine come in contact, precipitation of a sticky, stringy, viscous substance will usually occur. This can obviously plug a perforation or the formation. Normally, a diesel preflush will prevent the brine and plastic from mixing.

3. Acid brine ($CaCl_2$-$ZnCl_2$) can neutralize the catalyst used to set the plastic, thereby leaving the plastic in a fluid state. Again, a diesel slug should separate the fluids and prevent contamination.

4. Loss of large volumes of brine to a formation can reduce the permeability to hydrocarbons. This problem is most severe in multiple completion where zones are far apart (greater than 1,000 feet) and/or have abnormal density requirements for one or more zones.

The last item is the most important contributor. It is important that the hydrostatic head be carefully balanced with the formation pressure. An unusual example emphasizing the fluid-loss problem occurred when a 14.5 ppg $CaCl_2$-$ZnCl_2$ solution remained in a quadruple well for three weeks. Several unanticipated factors delayed completion of the high-pressure lower zone, and about 400 barrels of the brine were lost to the upper three zones, which never produced.

Actual damage to the formation by the brines may be a result of gross flooding. Laboratory tests have demonstrated that Illite (a clay mineral) is structurally disintegrated by strong $CaCl_2$-$ZnCl_2$ brine within 48 hours at temperatures of 200° F or greater (no damage by NaCl brines). However, this is not necessarily bad. Removal of clay fines could actually improve permeability if there were no detrimental side effects.

Laboratory consolidation tests have shown erratic results when the formation sample is flushed with brine prior to a simulated plastic squeeze consolidation, particularly at elevated temperatures. Many of these tests showed quite satisfactory residual permeability and consolidation strength. An adequate diesel preflush was one of the important variables, indicating the plastic-brine contact may have been the more responsible factor.

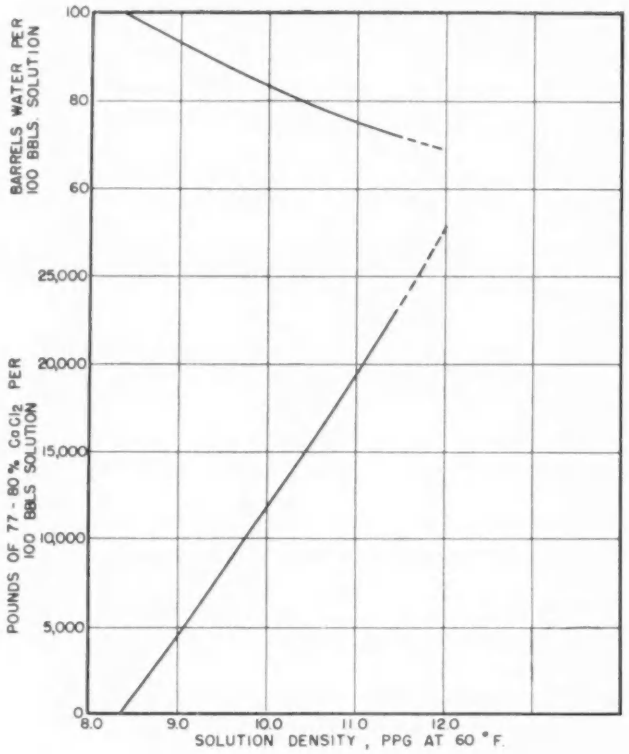

FIGURE 3—Mixing chart for $CaCl_2$ solutions (77-80 percent $CaCl_2$).

The best approach to circumvent the problems associated with completion operations is to alter the completion procedure. Recent developments in tubingless completions and through-tubing tools foretell the day when packers can be set and each zone perforated and completed under ideal conditions. Even now this approach can be used to solve the special situation where the bottom zone requires a higher density fluid than the upper zones.

After the upper zones are completed, all production packers, tubing, etc., are run into the hole and the packers are set. The bottom zone can then be perforated and completed through tubing under the higher density brine without ever exposing the upper zones to a high bore-to-formation pressure gradient.

Incorporation of a low-solids, fluid-loss control system into the brines also has some promise. However, one must be careful to balance the desirability of fluid-loss control with the disadvantage of possible fracturing during squeeze operations. A combination technique utilizing through-tubing completion techniques and low-solids, low-fluid loss brines may well be developed in the foreseeable future.

PACKER FLUIDS

Severe gelling and settling problems have been encountered with some muds used as packer fluids in deep, high-temperature, high-pressure wells. Two very significant data points were obtained early in the development of the offshore area when two single-completion wells had to be pulled to change out internally corroded tubing (Table 1).

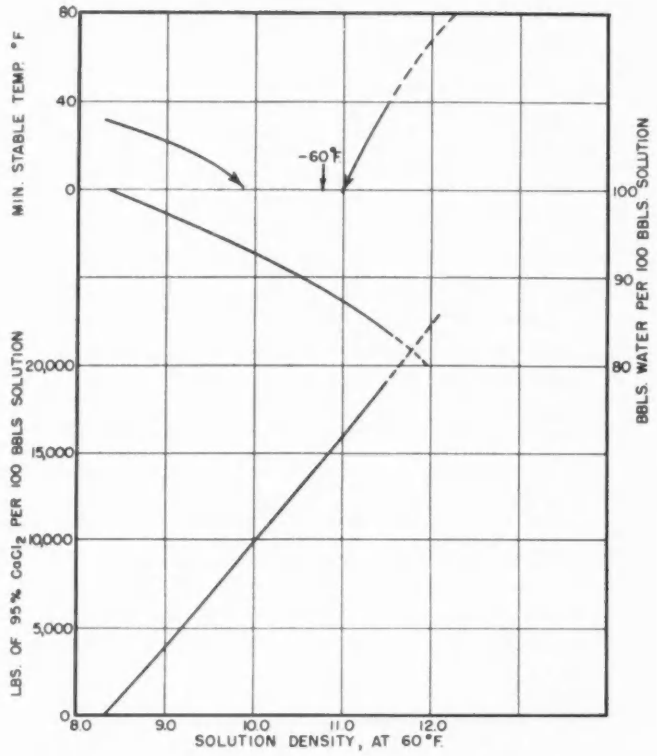

FIGURE 4—Mixing chart for $CaCl_2$ solutions (95 percent $CaCl_2$).

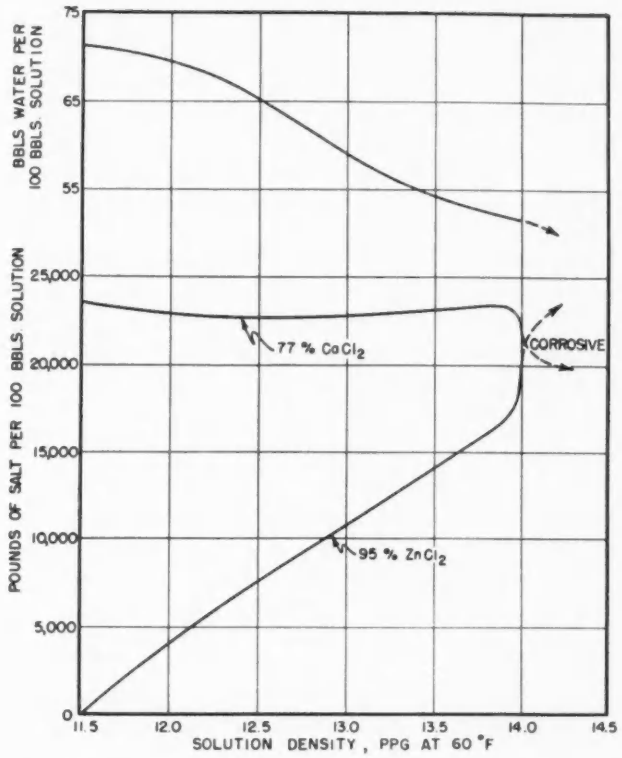

FIGURE 5—Mixing chart for $ZnCl_2$-$CaCl_2$ brines (77-80 percent $CaCl_2$).

TABLE 1—Costs of workovers with gelled muds.

	Well B	Well C
Depth, Ft.	12,389	12,469
Casing, size, in.	7	5½
Packer depth, ft.	12,085	12,390
Lime-base mud, ppg	16.1	15.8
Cost of workover*	$174,000	$148,000
Days required	39	27
Estimated cost, no washover required*	$ 94,500	$ 81,200

* Includes approximately $55,000 material replacement in each well

Jobs described in Table 1 drove home two significant facts. First, washover operations could be prohibitively expensive and considerable expense at the time of completion could be justified to prevent the problem from ever developing. Secondly, and even more important, it would be virtually impossible to wash over a triple or quadruple completion at any cost.

Because the devolpment of multiple completions was still in its infancy, it became imperative to obtain a satisfactory, practical solution to the problem without delay, before a large number of multiples were completed. Studies indicated that a true salt solution offered the best possibility for success.

It can be correctly argued that other mud systems may be less susceptible to gelling or settling than the lime-base mud cited. However, design, formulation and maintenance of a system that will not solidify or settle over a period of years and still maintain adequate gel strength to support the weight material is a very tricky proposition. Mud systems are still being used for densities above 14 ppg, but brines offer the best answer in the applicable density range.

The problem of brine corrosivity thus becomes extremely important. Because the fluid will be in contact with the tubing and the casing for several years, the corrosion rate must be held quite low, primarily to protect the casing. A pentration rate of 0.005 inch per year will seriously weaken casing in 20 years.

The full impact of the importance of corrosion was emphasized relatively early. $CaCl_2$ and $NaNO_3$ were two of the salt solutions initially used. Stress corrosion cracking failures occurred in Well J (Table 2) with sodium-nitrate fluid during completion operations. Extensive laboratory studies have since shown that such failures are to be expected under almost all conditions present in oil-field operations.[1]

Both $CaCl_2$ and $NaNO_3$ solutions had a density limit of about 11.5 ppg. Mixing the two salts can result in solutions having densities up to 13.5 ppg, which were used in several wells. Both laboratory tests and field experience have subsequently shown that this mixture is severely corrosive.[2]

Extremely localized pitting has penetrated tubing in less than one year. The attack can occur under a wide variety of conditions. Laboratory studies, substantiated by field experience, indicate the system can be passive for a period of time until activated by certain materials (e.g., CO_2). Extensive workover costs offer ample evidence that:

1. *Nitrates are not suitable for packer fluids in any form.*

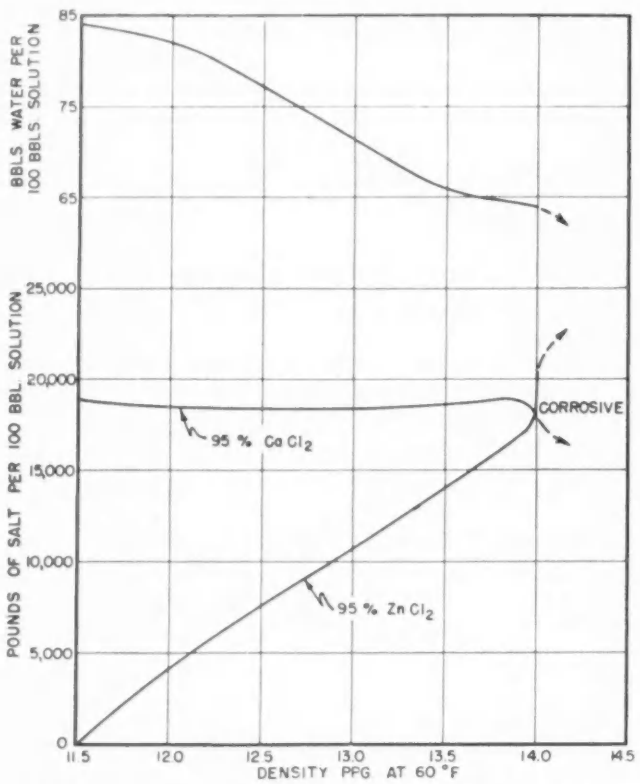

FIGURE 6—Mixing chart for $ZnCl_2$-$CaCl_2$ brines (95 percent $CaCl_2$).

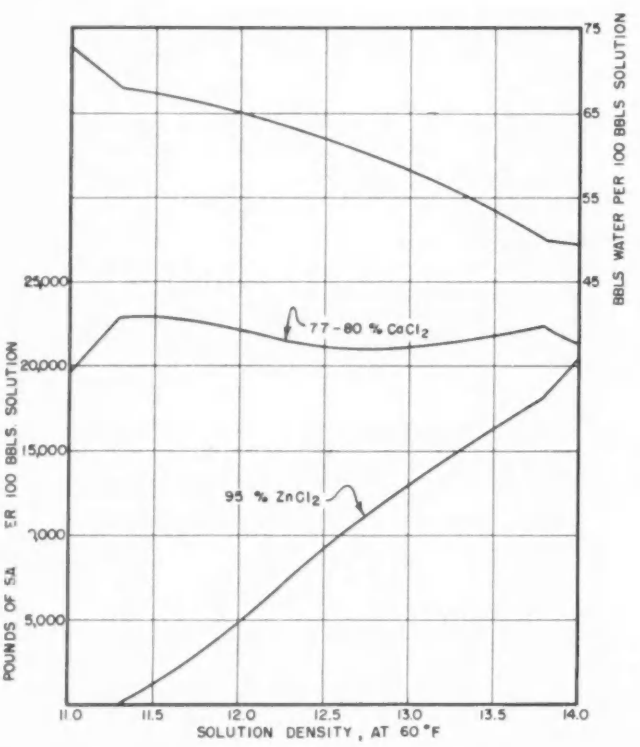

FIGURE 7—Mixing chart for $ZnCl_2$-$CaCl_2$ brines stable above 32° F. (77-80 percent $CaCl_2$).

2. Each brine system should be adequately tested *before* it is used.

It should be pointed out that, whereas corrosion was involved in each instance, other factors frequently contributed to the decision to rework the wells cited in Table 2.

TABLE 2—Costs of workovers associated with nitrate-containing packer fluids*

Well	D	E	F	G	H	I	J	K
Completions	4	2	3	3	2	4	3	2
Workover costs (thousands)	476	211	52	38	47	269	78	127

* Four additional wells were completed with nitrate-containing fluid which has since been displaced. Two are known to have suffered damage, but workovers cannot be economically justified on any of the four.

It is necessary to point out that no damage has been observed in any system that has not contained nitrates. No tubing exposed to $CaCl_2$-$ZnCl_2$ fluid for an appreciable length of time has been pulled yet, with the longest exposure now being slightly over two years. One well with a $CaCl_2$ fluid was examined during a workover after one year's exposure, and no significant corrosion could be found.

Also, in the numerous workovers performed in wells with the recommended salt solutions in the annulus, there have been no instances where workover operations have been hampered by a down-the-hole settling, precipitation or bridging in the salt solution.

SOLUTION REQUIREMENTS

On the basis of the preceding discussion and other considerations, requirements for a brine fluid can be summarized as follows:

Density—Densities up to 20 ppg could be used. Solutions to 14 ppg have been used so far.

Corrosivity—Uninhibited corrosion rates must be less than 0.005 inch per year penetration. Inhibitors can not be relied on to give long-term protection against a more corrosive material.

Effect on formation—The fluid should have a minimum detrimental effect on the formation in the event of appreciable fluid loss.

Compatibility—Brines should be compatible with other operations, although some changes in "standard" operating procedures might be required.

Safety—Materials used should not constitute an undue hazard to the personnel or equipment. This would apply to shipment, storage and disposal, as well as to actual use.

Cost—The cheapest system that will meet the other criteria is desirable. At some level, the whole technique might well price itself out of economic usefulness.

From a survey of several hundred single or mixed salt solutions, the three systems cited earlier have been found to be the best and simplest ones for the density range 8.33 to 14.0 ppg. There are other systems that might be satisfactory in the 8.33 to 11.5 ppg range, but there is no alternative beyond 11.5 ppg.

The $CaCl_2$-$ZnCl_2$ system is capable of densities up to 17 ppg, but the lack of adequate long-term corrosion data prevents recommending its use beyond 14.0 ppg at this time. It is hoped that the useful range of this system and brines in general can be extended to higher densities.

Figure 2 shows approximate material costs for various brine mixtures. These costs will vary with time, loca-

tion and quantities purchased. The values were calculated from the rates noted in Figure 2 and from the quantities plotted in the mixing charts (Figures 3-7). Quantities of fluid required will vary with depth and casing size. A good example for offshore efforts, 10,000 feet of 40-lb., 9⅝-inch casing, requires some 760 barrels plus working reserves.

GENERAL HANDLING PRECAUTIONS

Prior to 1960, each operator had to procure and mix his own salt solutions for offshore use. Several service companies now prepare solutions of prescribed density and composition and deliver them to location. Economics on this service appear to be quite good. Solutions in the 10.3-11.3 ppg range can be delivered to the location for less than the cost of salt at the dock.

Premixed solutions eliminate the need for the rig-time, equipment, and storage facilities necessary to mix solutions on location. There is also a good probability that the composition of the solution can be better controlled in shore-mixing facilities.

Storage. Sodium chloride, calcium chloride and zinc chloride should be given all the care and caution in handling that is given to caustic soda and hydrochloric acid. Dusting and spilling of any of the salts should be avoided, and since $CaCl_2$ and $ZnCl_2$ strongly attract water, the salts should be stored in dry warehouses and handled with care.

Mixing facilities and techniques. Common steel mud tanks and mud-handling equipment are satisfactory for mixing and using the dense brines. The brines are not harmful to pumps, packing or rubber hoses. However, continued aeration will increase corrosivity of the brines to surface equipment well above the level encountered in the stagnant, air-free annulus. Precautions should be taken to reduce the air contamination to a minimum value. Otherwise appreciable damage to steel surfaces can occur with prolonged contact.

The order of mixing is important. Inhibitors and oxygen scavengers should be dissolved into the water first with vigorous agitation. In make-up and maintenance work, they should be diluted about 1:10 with water before addition to the brine. This will assure uniform distribution throughout the solution.

The salts are added next in a manner designed to reduce dusting and splashing. The exact technique will vary with equipment and surroundings. One method involves the use of a circulating pump to wash the salts out of the container.

Solutions of $CaCl_2$ and $ZnCl_2$ can be prepared quicker if the larger particles of $CaCl_2$ are completely dissolved before the $ZnCl_2$ is added. It is important to note that $CaCl_2$ and $ZnCl_2$ both give off large amounts of heat when dissolved, with solution temperatures as high as 225° F. The solution can dissolve far more total salt at this temperature than at room temperature. Extreme caution should be taken to insure that *no more salt is dissolved than recommended* in the mixing charts (Figures 4-9), as solidification of the entire system can occur as the temperature drops.

Density is an adequate control criteria for NaCl and $CaCl_2$ solutions. However, in $ZnCl_2$-$CaCl_2$ systems, the $ZnCl_2$ to $CaCl_2$ ratio must be controlled to minimize corrosivity and cost. Accurate bookkeeping on quantities of material is sufficient for initial mixing, but water flows and fluid loss complicate the picture for make-up and maintenance work.

Fresh water (less than one percent total solids) is usually used in preparing the solutions. However, sea water or non-corrosive produced brines can also be used for NaCl and low-density $CaCl_2$ solutions. Sea water can be weighted to about 10.8 ppg with $CaCl_2$ before precipitation commences. Produced brines, sea water and fresh water should be checked out on a small scale to determine

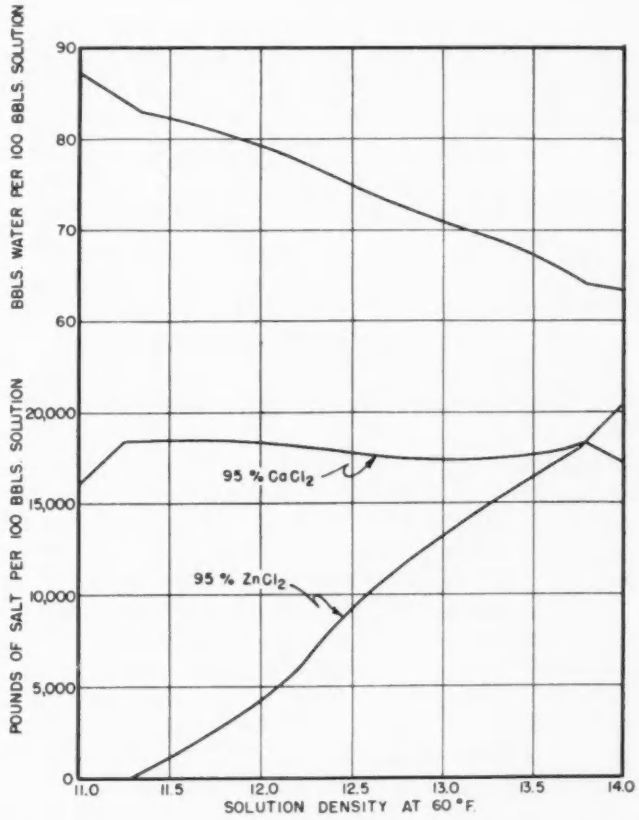

FIGURE 8—Mixing chart for $ZnCl_2$-$CaCl_2$ brines stable above 32° F. (95 percent $CaCl_2$).

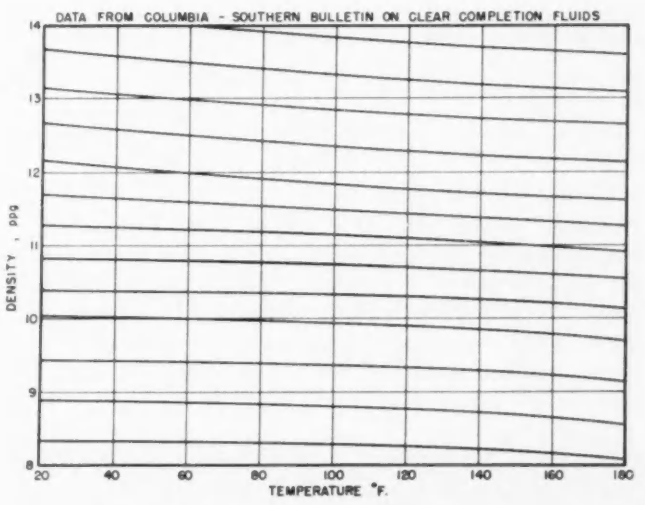

FIGURE 9—Effect of temperature on density.

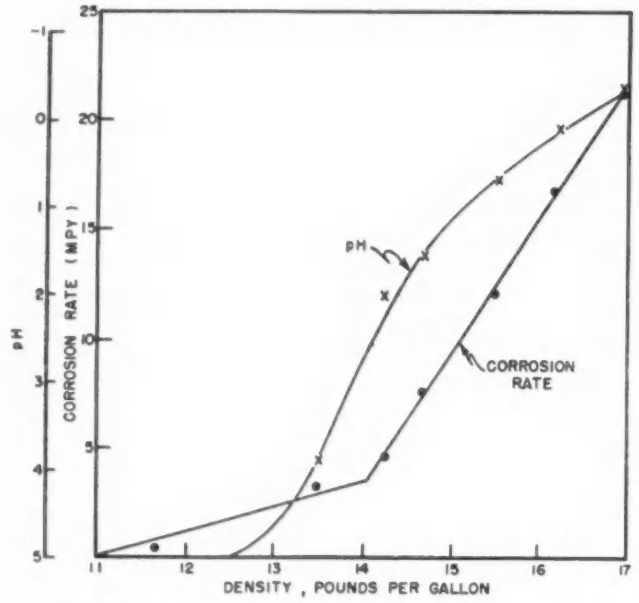

FIGURE 10—Corrosivities of $ZnCl_2$-$CaCl_2$ brines as a function of density.

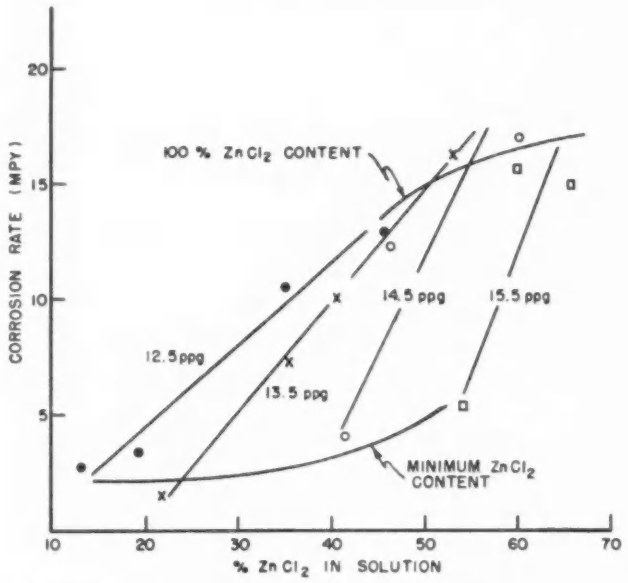

FIGURE 11—Corrosivities of $ZnCl_2$-$CaCl_2$ brines as a function of density and $ZnCl_2$ per $CaCl_2$ ratio.

compatability and limits with $CaCl_2$ and $CaCl_2$-$ZnCl_2$ systems. High carbonate, bicarbonate and sulfate content in the water can result in scaling problems downhole.

Safety hazard. The primary safety hazard involved in use of brines is physiological damage to personnel involved in mixing and handling of the solutions. Dangers, causes and preventive and remedial measures should be thoroughly discussed prior to use of the brines.

Sodium chloride salt and brines are not excessively hazardous. However, care should be taken to keep the concentrated solution and solids out of the eyes and off the skin and clothing. The drying action may cause mild skin irritation and cracking which can develop into serious damage. Thorough flushing with fresh water is the best first aid. Inhalation of the dust should be avoided.

Calcium chloride and zinc chloride are more serious problems. Both salts can cause severe skin and flesh burns if allowed to contact the skin for prolonged periods. Inhalation of dust can result in severe lung disorders, particularly with zinc chloride.

Both salts have a strong affinity for water and will extract it from the air, skin, eyes, leather boots, etc. In addition, $ZnCl_2$ reacts with the water to release HCl, which accounts for most of its dangerous properties. Thorough washing is again the best first aid. An adequate supply of fresh water should always be available at the work site for this purpose. A doctor should be consulted in any eye contamination or serious skin damage.

Protective clothing and safe operating procedures are the best preventative treatment. Safety goggles should be worn by every man working close to the brines. Rubber boots are far superior to leather ones with regard to both protection and boot life. Rubber or plastic rain suits and hats should be worn by those likely to contact the brine.

NaCl, 8.3-9.8 ppg. Material requirements for densities from 8.34-9.8 ppg are given in Figure 3, as are the minimum stable temperatures for the resulting solutions. For example, 100 barrels of 9.3 pound per gallon NaCl solution requires 6,200 pounds of NaCl and 93 barrels of fresh water. The resulting solution will freeze at 15° F.

Requirements for weighting up can also be *estimated* from this chart. Assume that it is necessary to increase the density from 9.3 to 9.8 pound per gallon. Final requirements are for 9,500 pounds of salt in 100 barrels of solution; 9,500 — 6,200 = 3,300 pounds to be added per 100 barrels of solution. This will actually yield 103 barrels of 9.7 pound per gallon solution, but this is sufficiently accurate for field use.

The temperature correction is linear for the entire density range from 40° F to well above 200° F, decreasing 0.02 pound per gallon for each 10° F temperature rise (Figure 10).

The corrosivity of a "pure" NaCl solution is quite low, less than 0.5 mils per year for temperatures up to 210° F. However, production experience indicates that there are contaminants that can make a brine very corrosive (e.g., carbon dioxide, hydrogen sulfide, oxygen, etc.).

In the specially prepared solutions being discussed, only oxygen should be present, and it will be quickly used up once the solution is sealed in the annulus. Corrosive produced gases could conceivably get into the annulus through leaky couplings. Additional corrosion protection can be obtained at nominal cost by adding an oxygen scavenger (3-4 pounds of sodium sulfite or 35 percent hydrazine solution per 100 barrels of solution) and a corrosion inhibitor that is *soluble* in the brine (4 gallons per 100 barrels).

$CaCl_2$, 8.3-11.5 ppg. Calcium chloride can be obtained as 77 to 80 percent or 95 percent salt. Mixing charts are given for both materials (Figure 4, 5). Mixing and calculations are similar to NaCl with two important exceptions. First, the solution will get hot (up to 225° F) when $CaCl_2$ is dissolved in water. Secondly, it is easy to exceed the stable solubility of $CaCl_2$ in the hot solutions.

For example, a 12.2 pound per gallon solution is stable

at 80° F; but, if the temperature of the solution drops to 60° F the entire system may solidify rather than having a small amount of solid salt drop to the bottom of the tank. This phenomena is particularly important in pumping down through cold sea water or in cold weather, when flow lines can plug solid in seconds.

The problem can be eliminated simply by never exceeding the density limit for the minimum temperature to be encountered (Figure 5). For example, if a hard freeze of 20° F is expected, do not let the density get above 11.2 pounds per gallon. Temperature corrections are shown in Figure 10.

Corrosion characteristics of $CaCl_2$ solutions are essentially the same as NaCl solutions. Similar treatment can be used for supplemental protection with one exception. Sodium sulfite cannot be used as an oxygen scavenger, because calcium sulfite will precipitate from soultion.

$CaCl_2$-$ZnCl_2$, 11.5-14.0 ppg. Mixing data for solutions stable to 60° F for this system are given in Figures 6 and 7, for 77-80 percent and 95 percent $CaCl_2$, respectively. As with the $CaCl_2$ solution, precautions should be taken to insure that, for a particular $ZnCl_2$ to $CaCl_2$ ratio, the total salt content does not exceed that given in the mixing charts; otherwise solidification and/or precipitation can occur.

For solutions stable to lower temperatures, it will be necessary to increase the $ZnCl_2$ to $CaCl_2$ ratio slightly. Figures 8 and 9 give mixing values for solutions stable to 32° F. The densities are still for 60° F, however.

The corrosivity of the system is related to the $ZnCl_2$ content. For this reason, it is mandatory that a minimum amount of $ZnCl_2$ be used to obtain the desired density and temperature stability. The values given in the mixing charts are for minimum $ZnCl_2$ contents.

Furthermore, minimum $ZnCl_2$ content also corresponds to minimum cost. Figures 11 and 12 illustrate the effect of composition on the corrosivities. These data are for 1020 steel coupons immersed in brine at 210° F for 30 days. This represents the maximum rates to be encountered in the wellbore. The 1020 steel showed slightly higher rates than tubular-goods steels, and the time-rate studies indicate that rate diminishes with time. Two observations are immediately apparent:

1. The corrosivity of minimum $ZnCl_2$ content solutions increases markedly above 14 ppg.

2. High $ZnCl_2$ content results in corrosion rates far above that obtained with minimum $ZnCl_2$ content at the same density.

The corrosivity of the $ZnCl_2$ is the result of its reaction with water to liberate hydrochloric acid. There are a number of inhibitors available for hydrochloric acid. Many of the "water soluble" inhibitors are insoluble in these 40 to 60 percent brines. Most of the soluble ones will do a fairly good job of inhibiting the corrosion in short-term (weeks) laboratory tests, yielding 70 to 95 percent protection.

There are *no* long-term (years) stability or effectiveness data for these inhibitors under well conditions. The authors do not believe that they can be depended upon to inhibit an otherwise highly corrosive system for the life of the well. For this reason, use of $ZnCl_2$-$CaCl_2$ brines above the density of 14 pounds per gallon is not recommended for extended periods of time, even though solutions with densities up to 17 pounds per gallon can be prepared. It is recommended that a brine-soluble acid inhibitor be used as with NaCl and $CaCl_2$ solutions to take advantage of the supplemental protection it can offer. Neither hydrazine nor sodium sulfite can be used as an oxygen scavenger because of precipitation problems.

This article taken from the paper "Developments in the Use of Dense Brines as Packer Fluids", presented at the Southern District Meeting of API, Shreveport, La., March 1961.

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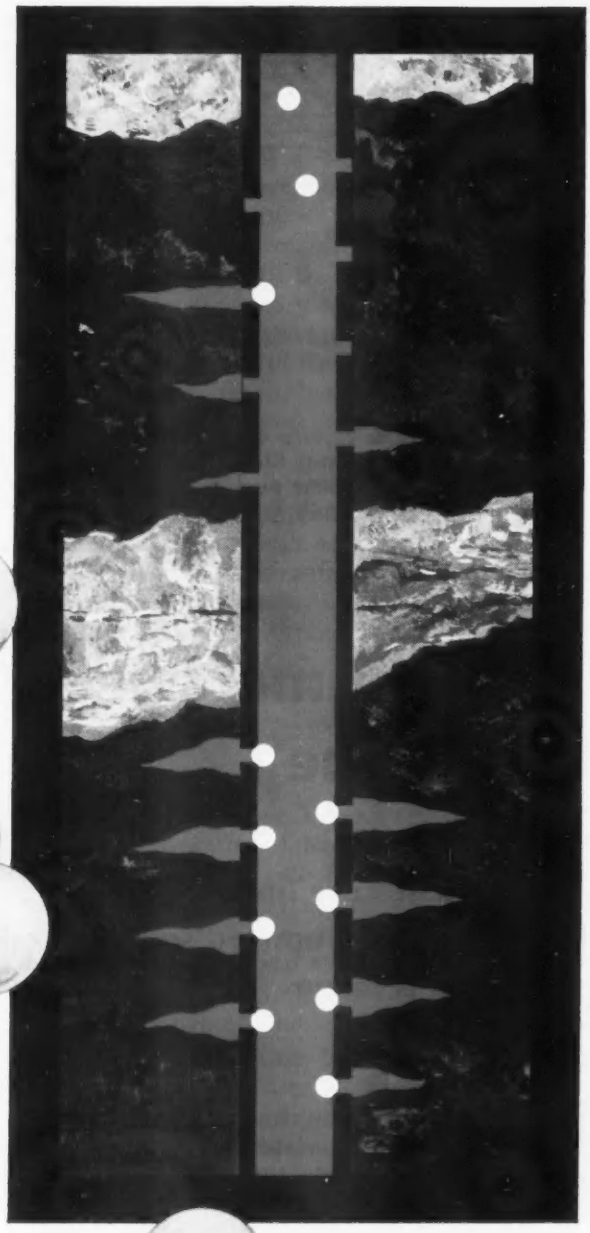

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Halliburton Company
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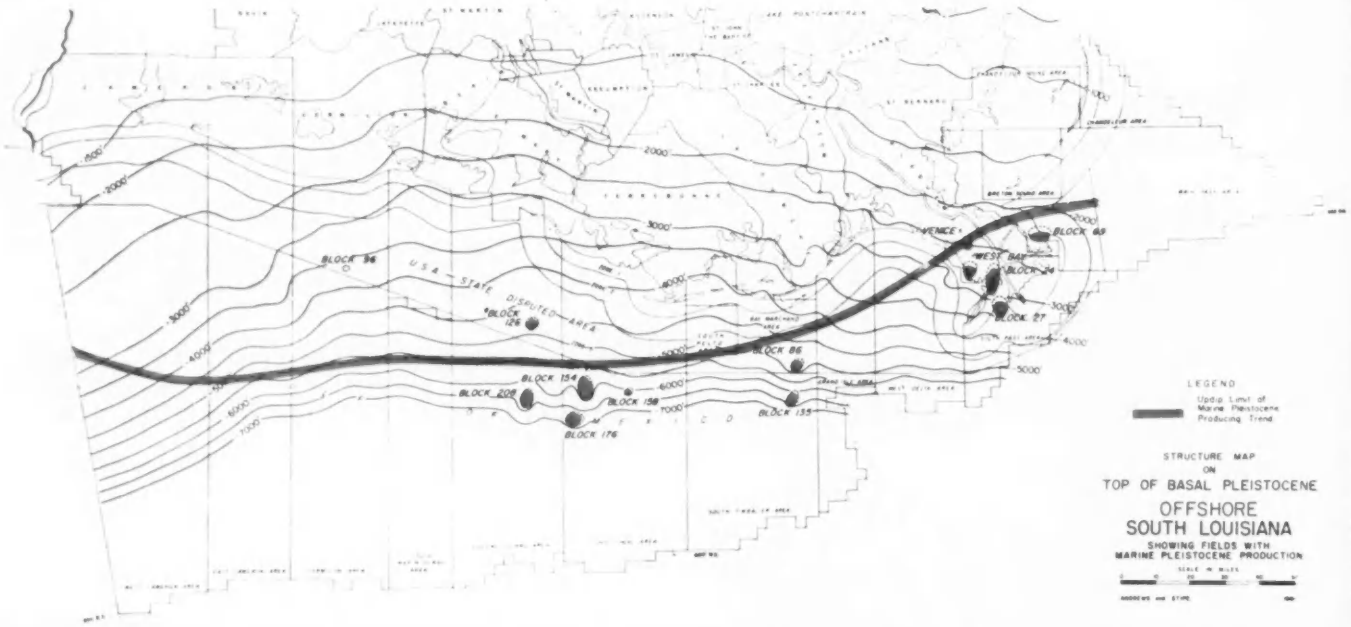


FIGURE 1—Map shows areas of Pleistocene hydrocarbon reserves offshore from Louisiana and structural contours on top of the basal Pleistocene. More prolific Pleistocene fields are expected to be found farther down dip. Not shown are three additional fields capable of Pleistocene production; West Delta Block 55, Ship Shoal Block 186, and South Timbalier Block 131. Good Pleistocene sand development should extend beyond current water-depth drilling limits.

In offshore Louisiana, some commercial oil, gas indigenous to Pleistocene

Editor's Note: There's little, if any, doubt about it—commercial oil and gas are being found in Pleistocene sands in the Louisiana offshore, and there is likewise little or no doubt that these accumulations are in many cases indigenous to Pleistocene formations in which they occur. Until recent years theories persisted to the effect that oil is not indigenous to formations younger than Pliocene. Yet recent radiocarbon dating work in connection with some "young" crudes places them in the 5,000-10,000 years age range. And crude oil has apparently been observed in actual development in eastern Venezuela in formations which apparently date to early historic time.

This article is extremely significant to exploration in offshore marine waters on continental shelves all over the world, where Pleistocene sediments were deposited and subsequently buried by still younger beds laid down in rising oceans swollen by water from melting polar ice sheets.

Bigger Pleistocene finds expected farther offshore; upward seepage from older beds is minor

By Donald I. Andrews, Geologist, Rodgers, Seglund and Shaw Associates, New Orleans, La.
and Jack C. Stipe, District Exploration Geologist, Southern Division, Kerr-McGee Oil Industries, Inc., New Orleans

AN UNUSUAL NEW geological concept is emerging along the Mississippi River delta and farther westward off the south Louisiana coast. As offshore drilling extends farther southward into deeper waters, well-developed marine sands of Pleistocene age are being found to contain substantial reserves of oil and gas, particularly gas.

Potential of the Pleistocene has been overshadowed by lucrative production found in underlying Pliocene and Miocene sands. These older sands attain their optimum development farther updip under relatively shal-

low offshore waters. Greater water depths and attendant drilling problems have been a primary deterrent to reaching the optimum development of downdip Pleistocene sands. In the updip area of their marine development these Pleistocene sands have been considered primarily as trouble zones in which blowouts and lost circulation are likely to occur in drilling for older formations.

Sand development and hydrocarbon accumulation in the Pleistocene are similar to the underlying Pliocene and older beds in that they continue the cyclical pattern of transgressive-regressive, offlap deposition, and reservoir characteristics rapidly improve downdip. Near-shore and continental massive sand facies produce oil and gas on many large structures updip from the "marine producing trend" shown in Figure 1. However, it is believed that the accumulation in this updip Pleistocene facies is primarily the result of seepage from older beds. Production from this facies will represent *only a small fraction* of the total Pleistocene reserves.

Most of these reserves will be found in the intermediate facies of alternating marine sands and shales that lie gulfward of the updip producing trend line shown in Figure 1. Downdip limits of the Pleistocene producing trend are of course unknown, but may well be dictated by economics rather than sand conditions.

Current reserves in the intermediate facies are concentrated near the present Mississippi River delta. This is because the delta, being built out onto the continental shelf has made this facies accessible to present-day drilling. Recently, however, production has been found in Pleistocene approximately 100 miles to the west in water depths of 100 feet. As more advanced deep-water drilling equipment becomes available these sands will be primary objectives and reserves will be substantially increased.

Other Pleistocene beds have produced oil and gas in the United States, notably in Texas (e.g. Lissie formation), Utah (Salt Lake area) and California (e.g. Tulare formation). However, petroleum accumulations in these formations generally do not appear to be indigenous to the Pleistocene. They are thought instead to be primarily due to migration and seepage from older beds, in some cases across unconformities, and into overlying beds of Pleistocene non-marine sands and gravels.

Asphaltic or "tar sands" have been quarried for years in California and in some cases the tars exposed at the surface act as a seal which entraps downdip oil and gas. The famous La Brea tar pits are an example of seepage from older beds into the Pleistocene. There are, however, shows of oil and gas reported in marine Pleistocene sands in California's Ventura Basin that are probably indigenous to those beds.

Dip correlations. Most previous literature on Pleistocene deals with the alluvial sequence. At the surface these beds are exposed onshore all along the Gulf Coast from the Rio Grande River eastward to northwestern Florida. Onshore Pleistocene surface formations are mostly younger Pleistocene in age and consist mainly of stream deposits, deltaic plains and alluvium, with various "terraces" or ancient shorelines having been developed throughout the area. There has been some confusion as to the names, correlations, etc., of the U.S. Gulf Coast Pleistocene sediments from one area to another. An extremely comprehensive paper by Doering[1] has done much to clarify this situation.

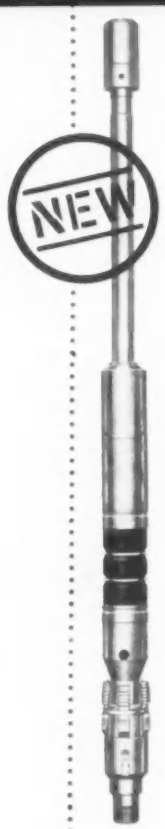
After World War II the numerous wells drilled in coastal and offshore Louisiana enabled stratigraphers and paleontologists to interpret better the relationships between the updip surface terraces and alluvium and the downdip subsurface marine beds. Certain papers[1,2,3,4,5] (to cite only a few) have discussed correlations from the updip alluvial sequence into the downdip subsurface marine section. Trowbridge[3] noted that the most nearly complete record of Pleistocene history in the United States should be found in the Gulf Coast area and the offshore continental shelf.

Akers and Holck[5] remark that some of the younger beds of offshore Louisiana may constitute the thickest Pleistocene deposits in the world. They especially concentrated on relating the subsurface marine beds to the updip alluvium. Through studies involving cores and over 100 electric logs, the updip alluvial deposits were correlated with their marine equivalents in the Southwest Pass area. Figure 2 shows (at the left) the electric log chosen as a type log of the marine facies. Although these authors did not agree with portions of previous work[4] they note that these differences in opinion arise in large measure because of the difficulty of extending correlations in the subsurface from an alluvial sequence through a transition zone into the marine section definitely developed in the Southwest Pass area.

Plio-Pleistocene contact. Available information allows only a very generalized stratigraphic and paleontological classification of the subsurface marine Pleistocene facies. With various modifications, particularly in local areas, some paleontologists have attempted to utilize the classification shown in Figure 3. Of those Pleistocene microfauna shown in Figure 3, the "Lenticulina" assemblage appears to be the most useful. This assemblage usually occurs near the base of the "upper marine (shale) section," and is considered by many to mark the "top of the basal Pleistocene" (Figure 1). The contours shown in Figure 1 are drawn on this horizon. Some paleontologists and geologists interpret this point at the base of the "upper marine" shale to be the Pleistocene-Pliocene contact.

However, if the Pleistocene epoch began with the growth of continental glaciers and accompanying retreat of sea level, the oldest Pleistocene beds in this area theoretically should consist of a sandy, regressive facies. Therefore, since the "upper marine section" is a transgressive, marine shale facies, it appears quite logical to place the Pleistocene-Pliocene contact somewhere in the time-transitional sands occurring immediately below the base of the "upper marine" shale. Some workers arbitrarily place this contact at the top of the first definite shale facies encountered below the "upper marine" section.

However, the extreme difficulty in making reliable paleontological correlations, the relatively young age of the microfossils and their occurrence over long time periods, the absence of good regional markers, the lack of data in the shallower beds, the rapidly changing facies, and the confidential status of much data all add to the present impossibility of a definite classification. In the



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(right)
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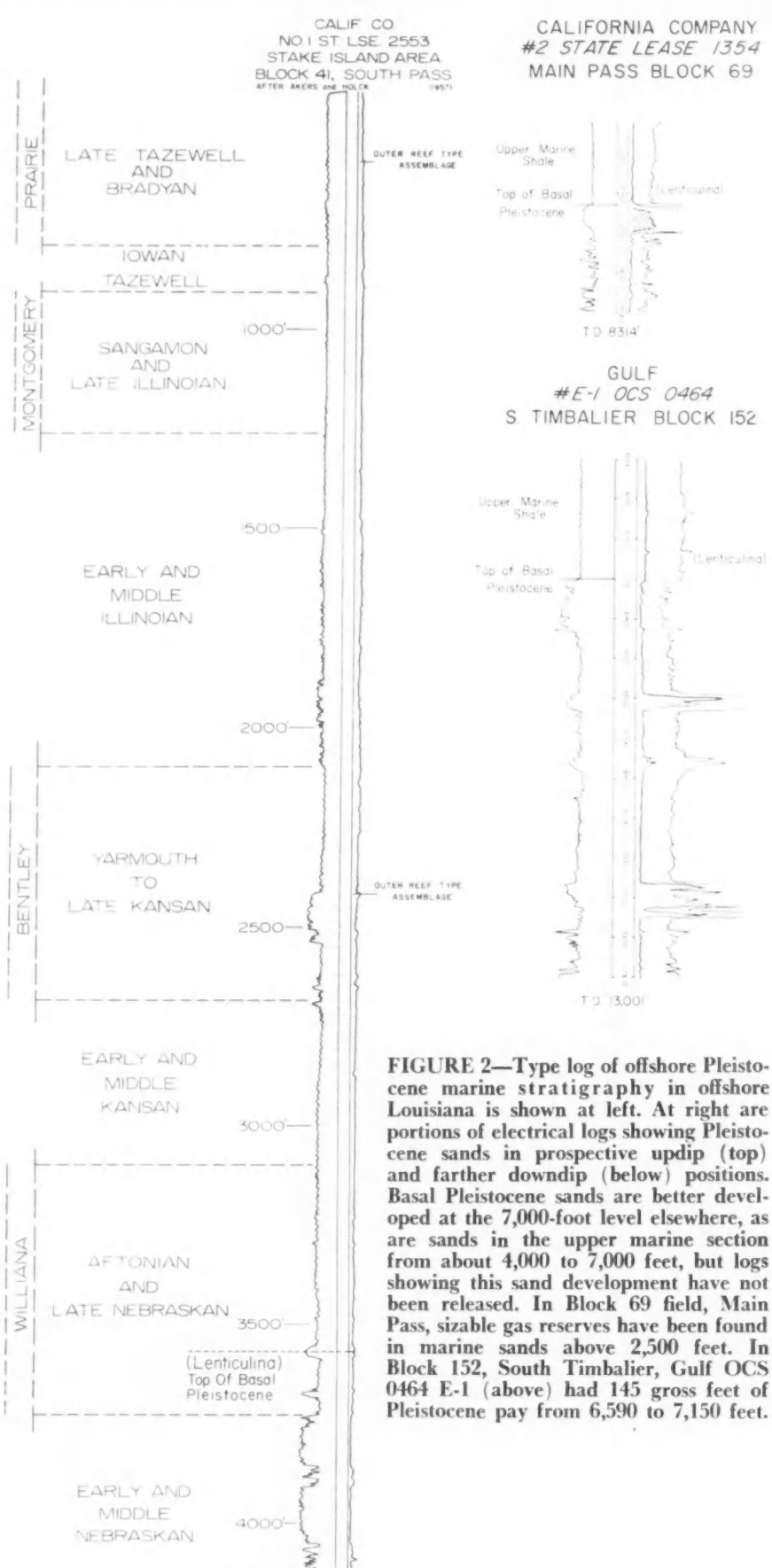

FIGURE 2—Type log of offshore Pleistocene marine stratigraphy in offshore Louisiana is shown at left. At right are portions of electrical logs showing Pleistocene sands in prospective updip (top) and farther downdip (below) positions. Basal Pleistocene sands are better developed at the 7,000-foot level elsewhere, as are sands in the upper marine section from about 4,000 to 7,000 feet, but logs showing this sand development have not been released. In Block 69 field, Main Pass, sizable gas reserves have been found in marine sands above 2,500 feet. In Block 152, South Timbalier, Gulf OCS 0464 E-1 (above) had 145 gross feet of Pleistocene pay from 6,590 to 7,150 feet.

LOUISIANA PLEISTOCENE CLASSIFICATION

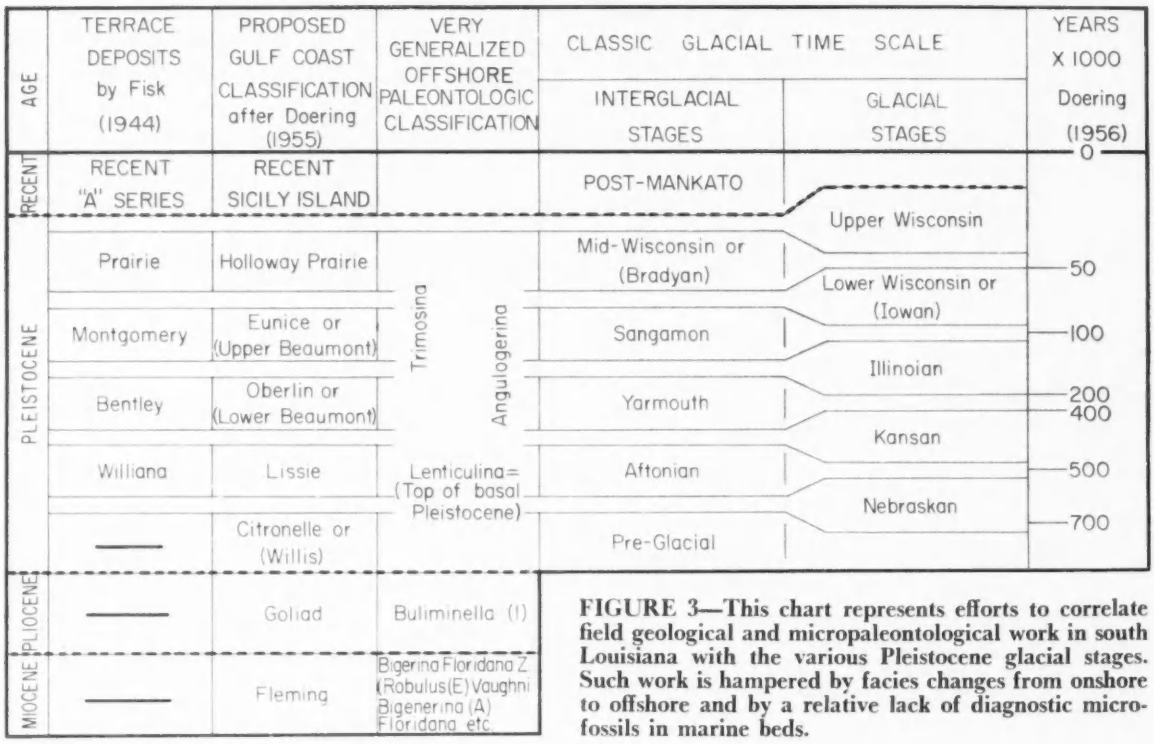

FIGURE 3—This chart represents efforts to correlate field geological and micropaleontological work in south Louisiana with the various Pleistocene glacial stages. Such work is hampered by facies changes from onshore to offshore and by a relative lack of diagnostic microfossils in marine beds.

transitional to marine beds the true regional contacts between the Pleistocene and Pliocene, and in some areas those between the Pliocene and Miocene cannot be picked with any certainty. (It could also be noted at this point that even with all the data available on the Miocene and Oligocene there still exists a controversy as to the true position of the Miocene-Oligocene contact). These boundary problems are not unique to the Pleistocene nor to the Gulf Coast, but are world-wide. The increasing control that will be obtained by additional drilling in the Gulf Coast, especially that done further offshore, should eventually result in a more accurate and truly reliable classification of the Pleistocene marine facies.

How sea level varied. Although this article is primarily concerned with those offshore marine Pleistocene sands that are capable of commercial oil and gas production, a brief review of general Pleistocene geologic history seems advisable in order to complete the picture.

The Quaternary period consists of the Pleistocene and Recent epochs, and is the youngest major subdivision of geologic time. The Pleistocene epoch is believed to have begun less than a million years ago with the development and spread of great continental glaciers over large areas of the earth's surface. Vast areas of the northern United States were covered with glacial ice, and as temperature zones moved southward the northern United States developed an Arctic climate.

Tremendous quantities of water were evaporated and withheld from the oceans during the creation and development of these continental glaciers. Major fluctuations of sea level occurred as these great masses of ice formed, and then melted. At different times the Pleistocene shorelines were located farther onshore and offshore than that of the present. Various estimates of the magnitude of these fluctuations suggest a sea level lowering during the last (Wisconsin) glaciation of as much as 150 to 450 feet below the present level. During such times the British Isles were joined to the mainland, and a land bridge stretched from Siberia to Alaska. Trowbridge[3] estimates that if all of the presently existing glacial ice were melted, sea level would rise approximately 150 feet.

With some variations it is generally believed that at least four "glacial ages" occurred during the Pleistocene (Figure 3). The term "glacial age" is somewhat controversial but is summarized and described by Zimmerman[6] as being "the time defined by initial growth and maximum expansion of continental glaciers and the attending sea level fall." An "Interglacial age" thence is described as "the time defined by initial general retreat and relative restriction of continental glaciers, and the attending sea level rise and subsequent stand."

Other sources interpret a glacial age as being bounded by the active life of major continental glaciers as expressed by the time span from the beginning of sea level fall to the ending of sea level rise. There is some question now as to whether the present time is an interglacial age or whether the Pleistocene epoch ended some 11,000-15,000 years ago with the retreat of the last (Wisconsin) continental glaciers, together with a corresponding rise in sea level to that of the present. Sea level is believed to have risen from a 180-foot low to its present level approximately 6,000 years ago, and to have remained fairly stable since then. Some geologists include the "Recent" as part of the Pleistocene, thereby making Pleistocene synonomous with Quaternary. However, in this article the Recent is considered to have begun with the retreat of the last Wisconsin glacier and the accompanying rise

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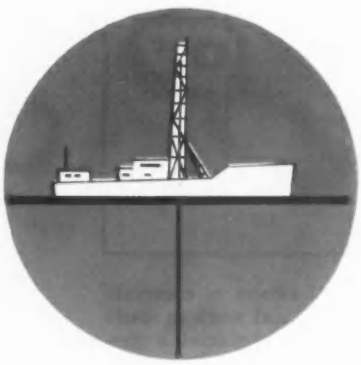

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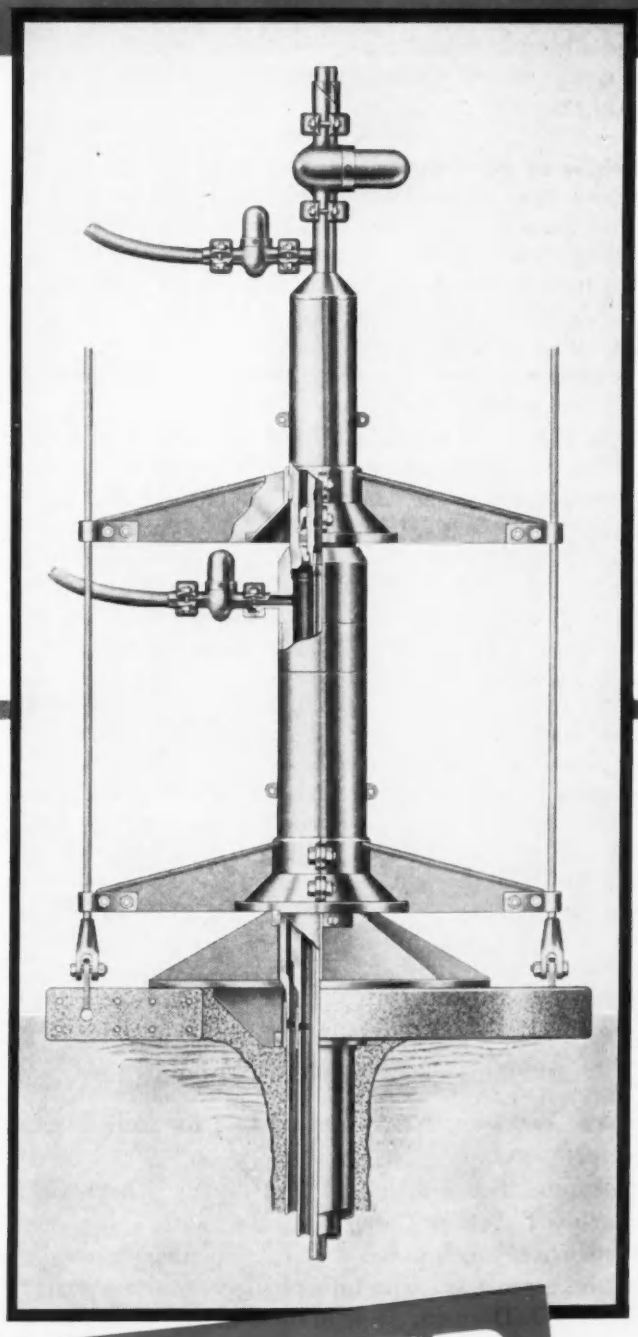

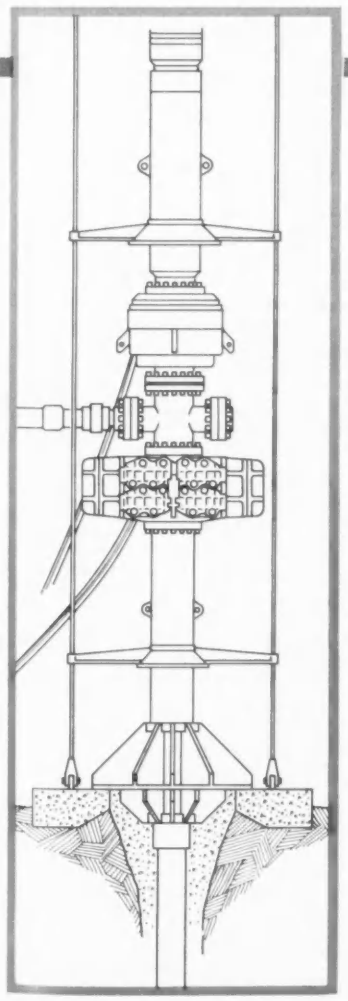

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in sea level, and is therefore a separate epoch within the Quaternary Period.

Prior to Pleistocene time those alternating marine Tertiary transgressions and regressions that deposited cyclical beds of Pliocene, Miocene, Oligocene, etc. age were caused primarily by intermittent subsidence in the Gulf Coast Geosyncline. However, during Pleistocene time the marine transgressions and regressions noted in the Gulf Coast section were a composite of the melting-freezing cycle and the tectonic cycle. This included the uplift and tilting of inland areas. Except in special cases, the separate effects of these cycles are not readily distinguishable.

Origin of Pleistocene oil and gas. Some authorities believe that offshore Louisiana Pleistocene oil and gas accumulations could not be indigenous to these marine sediments because of their relatively young age (less than one million years). However, many of the latest studies of Recent sediments[7,8] together with those on the origin, migration and accumulation of oil do not discount the probability of an indigenous Pleistocene origin for this offshore production.

As previously noted, much of the shallow Louisiana Pleistocene production that occurs in non-marine to transitional sands, particularly near the crests of salt domes, has undoubtedly seeped into these beds from below. However, there appears to be little reason to doubt that the origin and generation of the petroleum accumulation occurring in such wells as shown in Figure 2 was from anywhere but actually within the Pleistocene itself. Since the depositional history of these marine sands is so similar (except for age) to that of the older Pliocene, Miocene and Oligocene beds, the arguments used against *in situ* Pleistocene oil generation could theoretically be applied also to the older beds. This is a problem that is not easily resolved. As new studies currently under way are evaluated, much light will be shed on the generation of petroleum, especially as it relates to the younger sands.

ACKNOWLEDGMENTS

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The authors also wish to thank Larry Stansbury for his invaluable drafting services.

The authors propose to present for possible publication in *Transactions*, Gulf Coast Association of Geological Societies, November 1961, a manuscript on the same subject.

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About the Authors

Donald I. Andrews has been a member of the New Orleans oil and gas consulting firm of Rodgers, Seglund and Shaw Associates since 1959. He graduated from the Colorado School of Mines in 1950 with a degree in geological engineering and was then employed as a geologist by Continental Oil Company in Shreveport, La., before entering military service. After two years in the U.S. Army as a petroleum pipe line engineer he returned to Continental in Shreveport. In 1955 Andrews was transferred to New Orleans and in 1957 was promoted to district geologist for southwest Louisiana.

Jack C. Stipe is district geologist in charge of exploration for the Southern Division of Kerr-McGee Oil Industries, Inc. in New Orleans. He received his academic geological training at the University of Oklahoma and has been employed by Kerr-McGee since 1950. He worked in the company's Mid-Continent, West Texas and Rocky Mountain areas before being transferred into the geological department in 1953. He has been in the Gulf Coast area since early 1954 and has done subsurface studies throughout the Gulf Coast.

J. C. Stipe

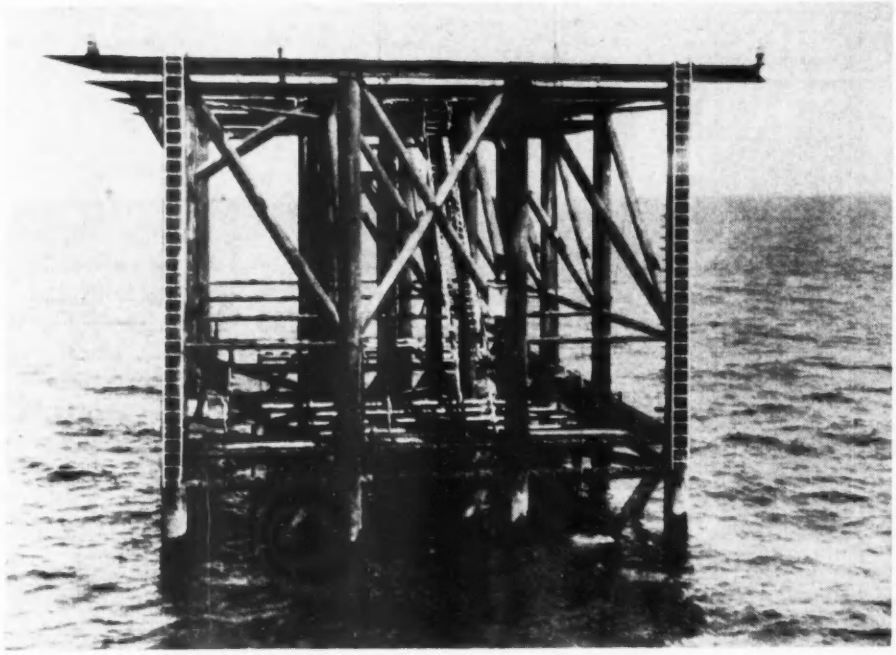
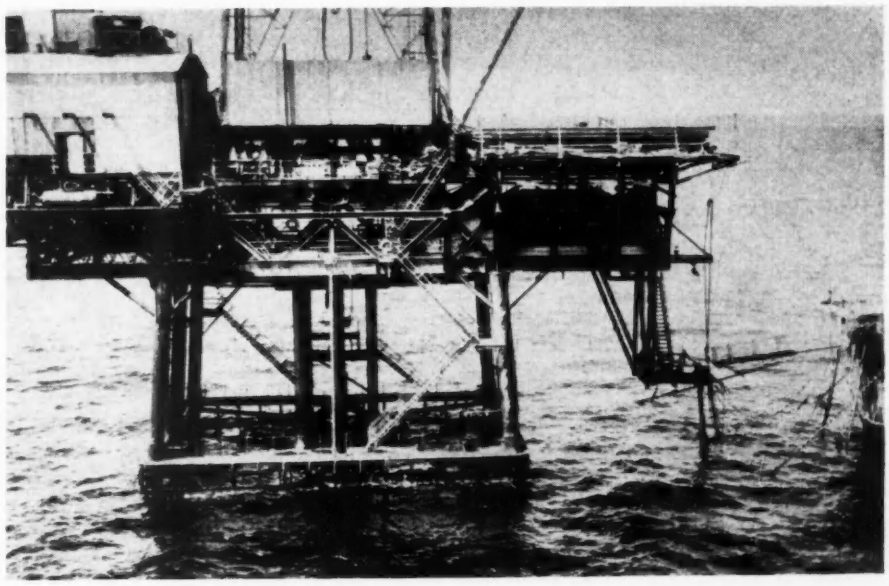


FIGURE 1—Old type structure had maze of bracing, large number of supporting piling. In many instances, increased horizontal loading imposed by the bracing members was responsible for damage during heavy seas.

FIGURE 2—New type structures have fewer piling and bracing has almost been eliminated. As a result, lateral forces contributing to flexing have been significantly reduced.



Good engineering has paid off in Gulf of Mexico operations. Although some structures have been damaged by storms and ship rammings, not one has collapsed

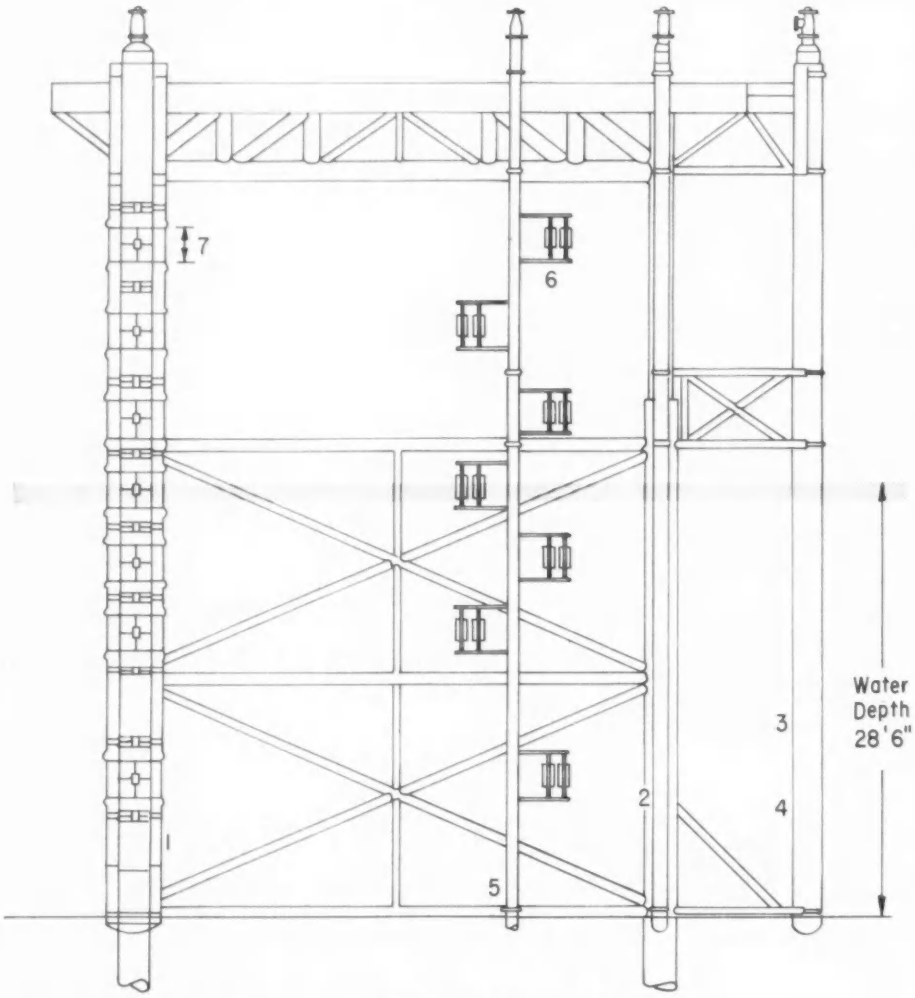
How safety is designed into offshore platforms

By H. E. Denzler, Jr.

Assistant to General Superintendent of Transportation
The California Company
New Orleans

RECENT STUDIES of wave forces combined with soil analyses and core data have resulted in better offshore platform structures. Pile design has been improved considerably and new structures now require fewer piles than those of a few years ago (Figures 1 and 2).

Experience has shown that it is impossible for an operator to standardize platform designs. Since operational circumstances on individual structures



1 4 Ft. Pile (Showing Section @ ℄ Typical Of All Test Piles)
2 1 Ft. Pile
3 2 Ft. Pile
4 3 Ft. Pile (20 Ft. Behind 2 Ft. Pile)
5 Velocity Sensing Assembly
6 Velocity Sensing Dynamometer
7 Force Ring Of Dynamometer
3 Wave Staffs Not Shown

FIGURE 3—Test pile installation in Bay Marchand, Louisiana, provided new information on wave forces. Drawing shows instrumentation used in project.

are never identical, each must be designed to accommodate specific equipment. Also, a structure must be designed especially for the water depth in which it is to be used and for existing subsoil conditions.

The oil industry has erected approximately 1,000 fixed platform structures in the Gulf of Mexico for drilling and producing purposes. None has failed in storm or hurricane except those designed to fail under such conditions. A complete structure with required producing equipment costs from $1 million to $2 million. Replacement caused by any disaster would cost two to three times as much.

The idea of operating on water locations is not new. A patent was issued to Thomas F. Rowland in 1869, on an "Improved Submarine Drilling Apparatus." His ideas resembled those in use today.

Offshore structural design must be planned with the following in mind:

- Elemental forces (waves, winds, currents, etc). These factors generally relate to each other.
- Foundation conditions.
- Construction methods.

Elemental forces were of particular concern prior to 1954, simply because no information was available concerning them. Some experience had been gained in Lake Maracaibo, Venezuela, and a few oceanographic studies had been made in other locations, but none applied to the Gulf of Mexico.

Additional factors to be considered in Gulf operations include:

1. Sudden and severe squalls, northers, tropical storms and hurricanes.

2. Maximum storm conditions are usually severe and have been known to reach full force in only a few hours with little or no warning.

3. Tropical storms and hurricanes are accompanied by storm tides which contribute to wave height and power by increasing water depth. Tides of 10-14 feet have been recorded.

Empirical formulas, derived from theoretical conclusions obtained from such oceanographic data as had been compiled prior to 1954, has been proven inapplicable and generally inaccurate.

In most cases, platform damage has been caused by insufficient elevation of main decks above the water surface. In several cases, this factor—in combination with the severance of pinned connections between the jackets and piles—caused the structures to lean as much as 15 degrees, but without any failure of major members.

To operate in deeper waters, it became more and more apparent that exact wave and wind force data were necessary if safe platforms were to be designed within economic limits. Thus, a wave study program was conducted by the California Company, The California Research Corporation and several other operators.

Purpose of the project was to determine the forces and characteristics of wave action on tubular piling under actual sea conditions, ranging from ordinary rough water to hurricanes. Several sizes of piling, ranging from one to four feet in diameter, were installed in 30 feet of water (Figure 3), and equipped with various instru-

Minimum surface area should be exposed to wave forces thus reducing horizontal loading on the structure when affected by wave action

ments. These instruments were used to record wave heights, lengths and forces at intervals throughout the length of the pile.

The sensing devices were connected to electrical recording equipment located in a specially built air condition house on the structure. Under ordinary conditions, recording instruments were controlled manually, but a programming unit was installed so data could be recorded automatically in the absence of an attendant. This programmer was particularly important because it was able to obtain wave data when personnel were evacuated due to hurricane conditions.

Measurements on thousands of waves were undertaken in The California Company's Bay Marchand field, Louisiana, and results far exceeded original expectations. Five hurricanes and a number of severe storms were experienced during the study period. The project failed to determine wave speeds with any reasonable degree of accuracy due to confusion of the seas and physical limitations of the platform and test piles. However, this was not of particular importance because the magnitude and position of wave pressures were recorded, and these are the factors of first importance in offshore structure design.

While wave heights and periods recorded at Bay Marchand provide an excellent yardstick for design in other locations having 30-foot water depths, conditions on the west coast of Florida and on the Texas Coast are likely to be different. Waves off the Florida coast should not reach the heights recorded; waves off the Texas coast should be higher. Also, periods probably will vary in each location. It is believed that wave pressure data obtained at Bay Marchand should apply equally to all comparable waves wherever they may occur.

The data had to be converted to usable proportions before it was of any use to offshore design engineers. For each wave there are about 600 points to read and plot. Then, forces must be calculated and answers plotted. This was accomplished with Standard Oil Company of California's computers in San Francisco. The result is a pressure contour graph showing forces within the wave (Figure 4). From a series of pressure contours, it then is possible to work out a design wave for the specific structure contemplated.

Data obtained from the original wave study have been useful in shallower water but cannot be relied upon in deep water because wave characteristics in deeper areas vary from those in 30-foot depths. Deep water waves will extend to greater heights, there will be less bottom drag and there may be less confusion—all of which would increase and probably change the forces. Recently, a new study was initiated in 100 feet of water to study this problem.

It must be emphaized that complete knowledge of wave forces have not yet been obtained. Additional in-

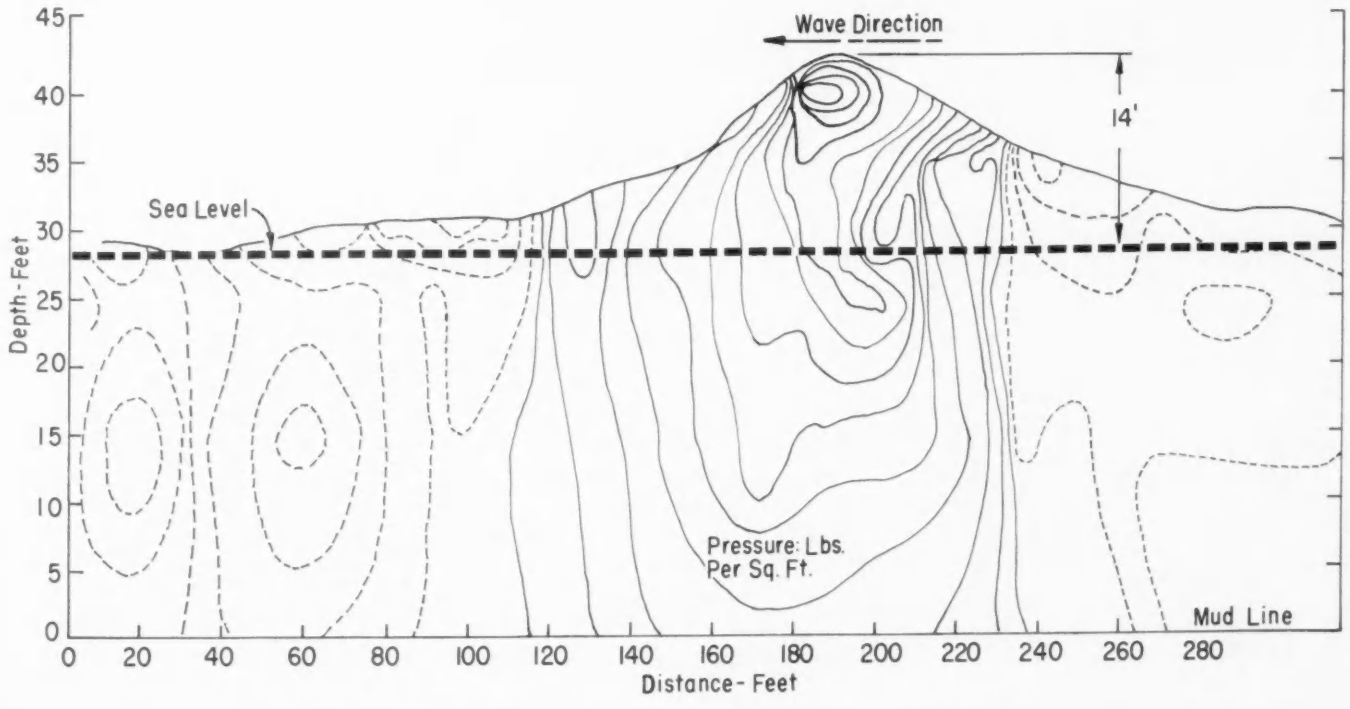


FIGURE 4—Pressure contour of a wave as it passes a test pile. Solid lines denote lines of equal pressure in psf in direction of wave travel. Dotted lines denote lines of equal pressure in psf in direction opposite to wave travel.

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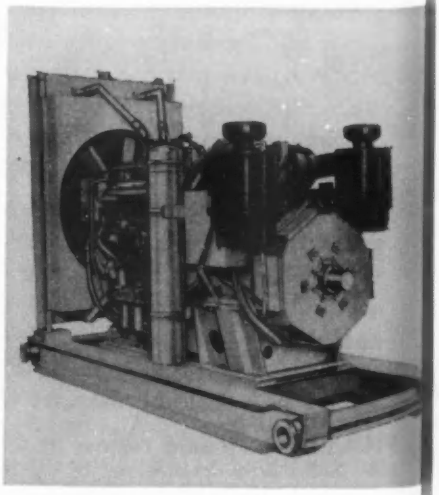

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formation must be obtained from deeper water and from many other geographical locations before final conclusions can be made.

It will be noted that piling used in the tests included all those diameters used in present day structures; consequently, a four-foot pile was the largest upon which tests were run. It may not prove accurate to extrapolate the anticipated forces developed through the wave study in conjunction with larger diameter piles needed in deeper waters. As piles become larger in diameter, consideration must be given the problems of collapse from either external or internal pressure. There also is need for more information on this subject.

Experience shows that minimum surface area should be exposed to wave forces. This applies to bracing, cat walks, stairways, pipe risers, work platforms and miscellaneous structures between water surface and main platform level. Each such member increases horizontal loading on the structure when affected by wave action, and is most susceptible to damage in violent storms.

Because of the factors mentioned above, it has been necessary to eliminate as many of these members as possible (Figures 1 and 2). Landing platforms and stairways, of course, must be erected. Pipe risers are enclosed in a single casing, and bracing is conspicuous by its absence. The contrast between the older and the more recent structures is apparent. Newer structures are more efficient, less costly to construct, erect and maintain and, in most instances, are probably even safer than the original structures.

The objective in the wave study was to measure the wave forces against the test piles, so all force measurements were made on the piles at various distances above the Gulf floor. No attempt was made to investigate the effect of waves upon scour at the mud line.

There is some information available on known cases of scour around piles, bottom bracing and supports, but there is practically no reliable information on its causes or ultimate extent. There have been a few instances of scour on structures where it was deemed advisabel to fill around the piles with rock to prevent further erosion.

Wave forces are the most critical elements of the design of a safe structure, but there are two others of almost equal importance—foundation condition and construction methods.

Piles behave in a more or less predictable manner under given conditions, structure fabrication and erection. Piling in the Gulf, however, met conditions rarely encountered elsewhere.

In one instance, 515-foot piles extended only 15 feet above the water surface. Below 100 feet of water and 100 feet of ooze, the pile was driven 300 feet into semi-consolidated clay. Under such conditions, lateral loading is an important factor. Offshore design engineers depended upon borings and soil analyses to supply information needed to design for lateral loading on the original structures. These data, correlated with information developed by the wave study project, have resulted in improved pile design and the recognition that fewer piles need to be used.

A typical 12-well platform five years ago used 32 piles, 2-feet in diameter. Today, a typical 12-well platform will use 4 piles, 3 feet in diameter. The piles in the newer structures are longer (they are driven deeper), and wall thickness of each pile has more than doubled. The reduction in the number of piles and the bracing needed to tie them together has reduced the lateral loading, and has reduced the amount of steel required in each structure.

Flexibility is natural to all long slender structures and must be considered. Reduction in the number of piling and the elimination of bracing obviously has reduced the lateral forces contributing to flexing. Experience proved that mechanical connections were impractical and, in fact, were undependable. Consequently, tie rods, pinned connections and bolted collars, etc., have been discontinued as bracing.

Each structure design should have a 50-year life. The main platform level will be above the waves of a 100-year hurricane, and the structure itself will be adequate for all hurricanes in a 50-year period. A 50-year life, of course, does not mean the structure will collapse in 50 years. Rather, it means that it will be as safe as in the beginning after withstanding all anticipated wave forces for 50 years.

Hurricane intensities differ, and there are many methods of rating intensities. Each method produces different results. Generally, the worst storms do not occur each year nor does each storm strike every section of the coast. Therefore, it is said of a given storm that its severity was such as would normally be expected somewhere along the coast only once in 10 years, 50 years, 100 years, etc.

Design criteria exceed anticipated forces of once-in-every-50-years storm conditions based on calculations that rank the widely-known Hurricane Audrey as being considerably less severe than a 50-year storm. Audrey passed through 30 to 40 offshore structures with minor damage.

Damage that did occur was to, and caused by, the decks of structures which were not clear of the wave crests. Platform height criteria currently in use are adequate to clear anticipated waves in 100-year storms.

These factors also preclude standardization of structure designs. One thousand offshore structures in the Gulf of Mexico have proven safe despite storms and ramming by merchant vessels. Two cases of ramming recorded to date showed severe structure damage but no collapse.

—The End

About the Author

H. E. Denzler, Jr., studied civil engineering at Purdue University. He joined the California Company in 1946, and has worked in offshore drilling operations since 1949. He is a member and past chairman of the Offshore Operators Committee, a member of API and currently secretary of the National Offshore Operations Panel. His present position is assistant to general superintendent of Transportation and Offshore Operations.

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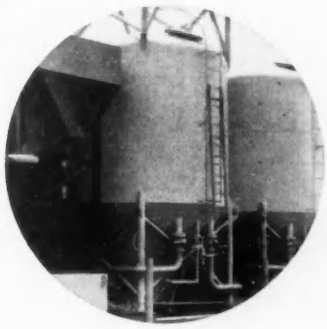

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Oil industry is achieving recovery of earning power

By L. J. Logan, Associate Editor, WORLD OIL

THE OIL INDUSTRY achieved an exceptionally good record of earnings in the first quarter of 1961. It will do so again in the current second quarter, despite some recent softening of prices of its products. For the industry as a whole, the first half of 1961 is proving to be the most profitable six months of the past four years, or since the time of the closure of the Suez Canal. For some companies, earnings this year are the best ever.

However, the industry may be completing its recovery from the troubles that began at midyear 1957. Earnings likely will continue good in the latter half of 1961. But they will be comparing then with relatively good earnings of the latter half of 1960. Increases then will be less impressive than those shown in 1961's first and second quarters.

The industry has traveled a generally rough detour road in getting off the highway at mid-1957 and finally now getting back on the pavement. Earnings have varied and been erratic. In 1957, they set records in the first half but declined in the latter half, as recession closed in. In 1958, they were the lowest in recent years during the first half, but improved in the second half.

In 1959, profits further improved sharply in the first half but then in the latter half were down somewhat from the previous year. In 1960, the earnings in the first half equaled the good results of the previous year, and in the latter half they further improved impressively. In 1961, the first half is bringing what might be called full recovery of earning power, and the latter half promises to extend this favorable status.

During the first quarter of this year, 41 oil companies reported an aggregate profit of $892,519,000, as shown in the table herewith. That was 14.2 percent more than the $781,483,000 they earned in the first quarter of 1960. The latter amount had been about the same as profits in the initial quarter of 1959.

The 41 companies in the table represent a large part of the world petroleum industry, including concerns of virtually all categories. Among the companies are the prominent international concerns: Standard of New Jersey, Standard of California, Socony Mobil, Gulf Oil Corporation, Texaco, Inc., and the Royal Dutch Shell Group. Those companies are doing better in the United States and Canada than in other countries, where oil surpluses and soft markets are limiting profits.

Primarily responsible for a more profitable first quarter in 1961 than in 1960 were better prices for petroleum products. Markets began to improve at midyear 1960, and better prices have prevailed until now, although they currently are sagging as surpluses show up. Also helping earnings are gains this year in demand for gasoline, kerosine and some other products, though total demand has not quite equaled that of 1960.

Another important cause of better earnings this year has been the industry-wide campaign of cost cutting and efficiency achievement. Although wages were increased in the industry at the beginning of this year.

Net Earnings of Some Oil Companies in First Quarter, 1961 and 1960

(All earnings per share are on basis of common shares outstanding March 31, 1961)

COMPANY	1st. Quarter 1961		1st. Quarter 1960		% Dif. 1st. Q. 1961-1960
	$ Thousand	$ Per Share	$ Thousand	$ Per Share	
Ambassador Oil Corporation	173	0.05	513	0.14	— 66.3
Amerada Petroleum Corporation	7,796	1.23	7,306	1.16	+ 6.7
Argo Oil Corporation	1,422	.74	1,004	.52	+ 41.6
Ashland Oil & Refining Company	3,570	.50	3,409	.52	+ 4.7
Atlantic Refining Company	14,870	1.60	8,726	.93	+ 70.4
Bishop Oil Company	35	.08	28	.06	+ 25.0
Champlin Oil & Refining Company	3,009	.71	1,874	.43	+ 60.6
Cities Service Company	14,752	1.37	12,974	1.21	+ 13.7
Clark Oil & Refining Corporation	261	.16	15	.01	+1640
Colorado Oil & Gas Corporation	1,136	.32	d180	d.10	
Continental Oil Company	16,037	.76	15,280	.72	+ 5.0
Crescent Petroleum Corporation	626	.30	714	.34	— 12.3
Delhi-Taylor Oil Company	2,100	.41	1,425	.27	+ 47.3
Getty Oil Company	3,117	.20	2,923	.18	+ 6.6
Gulf Oil Corporation	95,315	.92	81,824	.79	+ 16.5
*International Petroleum Company	8,400	.58	9,500	.65	— 11.6
Louisiana Land & Exploration Company	5,858	.65	5,604	.62	+ 4.5
Maracaibo Oil Exploration Corporation	51	.10	57	.12	— 10.5
Murphy Corporation	1,307	.39	1,148	.35	+ 13.9
Ohio Oil Company	10,493	.75	10,279	.74	+ 2.1
Phillips Petroleum Company	27,506	.80	25,804	.75	+ 6.6
Plymouth Oil Company	1,128	.43	282	.11	+ 300
Pure Oil Company	6,828	.69	6,702	.68	+ 1.9
Richfield Oil Corporation	5,423	1.34	6,995	1.73	— 22.5
†Royal Dutch-Shell Group	117,768	....	116,986	....	+ 0.7
*Royal Dutch Petroleum Company	70,661	.96	70,192	.95	+ 0.7
*Shell Oil Company	34,709	.57	34,545	.57	+ 0.5
*Shell Transport & Trading Company	47,107	.49	46,794	.49	+ 0.7
Signal Oil & Gas Company	4,087	.41	3,369	.34	+ 21.3
Sinclair Oil Corporation	16,096	1.06	12,647	.81	+ 27.3
*Sinclair Venezuelan Oil Co.	3,393	.84	3,038	.75	+ 11.7
Skelly Oil Company	6,495	1.15	5,909	1.04	+ 9.9
Socony-Mobil Oil Company, Inc.	59,800	1.23	47,200	.97	+ 26.7
Standard Oil Co. of California	65,973	1.04	60,728	.96	+ 8.6
Standard Oil Company (Indiana)	43,820	1.23	31,689	.89	+ 38.3
Standard Oil Company (Kentucky)	2,975	1.14	3,398	1.30	— 12.4
Standard Oil Company (New Jersey)	193,000	.89	170,000	.79	+ 13.5
Standard Oil Company (Ohio)	5,518	1.10	5,066	1.01	+ 8.9
Sun Oil Company	12,011	.92	8,790	.71	+ 36.6
Sunray Mid-Continent Oil Company	11,007	.57	9,440	.48	+ 16.6
Texaco, Incorporated	108,141	1.75	97,313	1.61	+ 11.1
Texas Pacific Coal & Oil Company	1,799	.46	2,104	.54	— 14.5
Tidewater Oil Company	10,979	.73	5,932	.38	+ 85.1
Union Oil Company of California	9,164	1.05	5,530	.63	+ 65.7
Universal Consolidated Oil Company	1,073	1.13	676	.70	+ 58.7
*Total, 41 Companies	892,519	....	781,483	....	+ 14.2

d. Deficit. * Excluded from totals because included as affiliates of other companies are: International (Standard, N.J.), Sinclair Venezuelan (96½% owned by Sinclair Oil Corp.), Shell Oil Co. (65.4% owned by Royal Dutch-Shell Group), Royal Dutch Petroleum (60% owner of Royal Dutch-Shell Group), and Shell Transport (40% owner of Royal Dutch-Shell Group). † Data reported by Royal Dutch-Shell Group have been converted here from pounds sterling at exchange rate of $2.80 per pound, and are divided below on basis that Group is owned 60% by Royal Dutch and 40% by Shell Transport.

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Stripper wells account for larger share of U.S. crude production

During a 12-year period, U.S. stripper wells increased their share of total U.S. crude production from 15.1 percent to 21.4 percent, but reflected downward trends in their share of total wells (from 72.9 percent to 66.7 percent) and total crude reserves (from 36.3 percent to 23.5 percent).

These trends are revealed by comparing WORLD OIL statistics with Interstate Oil Compact Commission annual reports on stripper wells. The comparisons in brief:

- During 1959, there were 392,535 wells classified as strippers—66.7 percent of the total producing wells in the U.S. This compares with 340,276 stripper wells reported five years earlier—66.6 percent of all U.S. wells. Twelve years earlier (1947) there were 310,892 strippers wells, accounting for 72.9 percent of the total.

- Production from stripper wells in 1959 accounted for 21.4 percent of total U.S. production with 533,499,695 barrels, for an increase of 22 million barrels over 1958. Five years earlier, stripper well production accounted for 18.7 percent of the U.S. total with 432.5 million barrels. In 1947, the percentage was 15.1 percent, with 279.7 million barrels.

- Primary and stripper well reserves totaled 7.46 billion barrels on January 1, 1960—accounting for 23.5 percent of the U.S. total crude reserves. In comparison, primary and secondary stripper well reserves totaled 8.1 billion barrels in 1957 for 26 percent of the total; 7.7 billion barrels in 1954, 26 percent of the total; 7.8 billion barrels in 1947, 36.3 percent of the total.

Stripper Well Production Increased 22 Million Barrels During 1959

STATE	No. of Stripper Wells[1]	Production From Stripper Wells Bbls.[2]	Abandonments	Average Daily Production Per Well	Acres[3]	In Thousands of Barrels			
						Total Production	Primary Reserves[4]	Secondary Reserves[5]	Total Primary & Secondary
Arkansas	4,791	8,700,174	15	4.98	66,135	26,317	43,730	45,980	89,710
California	21,317	60,908,964	176	7.83	136,370	307,072	688 093	507,250	1,195,343
Colorado	391	1,356,087	25	9.50	15,980	46,136	10,595	1,435	12,030
Illinois	28,430	76,458,600	805	7.37	567,125	78,439	586,709[6]	.....	586,709
Indiana	4,744	10,470,583	71	6.05	71,000	12,009	52,350	39,500	91,850
Kansas	35,400	56,705,152	1,432	4.39	878,000	119,519	318,998	96,685	415,683
Kentucky	11,275	13,442,075	200	3.27	31,120	26,343	53,500	40,000	93,500
Louisiana	9,182	12,357,903	337	3.69	204,186	318,891	98,800	69,800	168,600
Michigan	3,373	10,438,608	115	8.48	160,077	10,439	73,747	109,295	183,042
Mississippi	182	834,971	40	12.57	7,250	47,928	6,680	.....	6,680
Missouri	121	75,070	5	1.70	1,890	75	575	.....	575
Montana	3,077	3,675,040	0	3.27	104,377	29,857	33,651	111,143	144,794
Nebraska	58	138,779	28	6.56	2,830	22,227	930	1,750	2,680
New Mexico	1,226	2,386,494	10	5.33	67,370	105,704	19,088	37,000	56,088
New York	14,900	1,913,099	1,100	0.35	62,000	1,913	57,700	31,000	88,700
North Dakota	80	148,555	20	5.09	5,911	17,960	1,225	3,095	5,130
Ohio	16,934	5,978,000	677	0.97	147,915	5,978	53,900	5,000	58,900
Oklahoma	68 836	91,328,678	1,331	3.63	1,142,194	196,480	580,873	661,371	1,242,244
Pennsylvania	64,340	5,895,820	1,902	0.25	625,732	6,472	113,574[6]	380,110[7]	493,684
Tennessee	32	9,300	18	0.80	165	9	63	.....	63
Texas, Total	84,690	160,551,394	2,897	5.19	1,905,128	944,410	1,199,859	826,243	2,026,102
No. Texas	27,589	41,673,839	1,201	4.14	415,920	72,499	354,108	356,200	710,308
W. C. Texas	11,319	15,040,601	547	3.64	298,103	41,647	117,108	100,620	217,728
Texas, Other	45,782	103,836,954	1,149	6.21	1,191,105	830,264	728,643	369,423	1,098,066
Utah	15	10,197	7	1.86	860	39,891	80	.....	80
Virginia	13	3,992	0	0.84	100	4	20	.....	20
West Virginia	15,800	2,184,000	147	0.38	208,300	2,190	35,274	50,840	86,114
Wyoming	3,328	7,498,160	93	6.17	110,994	125,968	75,000	333,000	408,000
Totals	392,535	533,469,695	11,451	3.72	6,523,009	2,492,231	4,105,014	3,351,307	7,456,321

[1] Stripper wells indicate number of wells in nonprorated fields which are averaging less than 10 barrels per day per well, or, where the individual well production is known, it includes only those wells making less than this amount: fields classified as stripper, but because of secondary recovery operations are now producing in excess of 10 barrels per day per well, have continued to be considered as stripper wells.

[2] Represents total oil produced from those fields classified as stripper, with the exception of Mississippi, in which the production is from the wells reported.

[3] Includes estimated total acreage in those fields so classified, with the exception of Mississippi, in which only acreage attributed to stripper wells has been used.

[4] Additional oil which it is estimated will be recovered under primary methods from stripper well fields; in Illinois and Pennsylvania, the primary reserve represents oil to be recovered by present methods and includes recovery reserves of projects now in operation.

[5] Reserves over and above primary recovery which could be recovered from these fields by application of fluid injection; in New Mexico this includes total recovery from fields which are predominantly stripper well fields; in Illinois no estimate has been made.

[6] Secondary reserves of projects now in operation included with primary reserves.

[7] Estimated probable secondary recovery reserves.

Major exploration boom is in prospect for Australia

Country has many large, deep, marine sedimentary basins with favorable structure. Modern exploration methods promise significant discoveries

By R. C. Sprigg, Managing Director, Geosurveys of Australia Limited, Adelaide, South Australia

AUSTRALIA IS EXPECTED to experience a rapid expansion of exploration activity during the remainder of 1961 and subsequently. A major exploration boom within months may be forecast by significant geological break-throughs that are coming with increasing rapidity in the understanding of Australian sedimentary basin geology.

Covering a continent, Australia is an enormous country with numerous, extensive, sedimentary basins, 10,000 to 20,000 feet or more deep, many of them being marine. It also has favorable geological structure. The sedimentary basins occupy more than 1½ million square miles. In their deeper portions, few wells have penetrated the full sedimentary sections. Drilling has been based mainly on showings of oil in shallow water wells, and usually has not been guided by geological control or modern geophysical techniques.

Scientific exploration has been very limited so far and has occurred largely within the past few years. But recently introduced seismic techniques and other modern exploration methods already have greatly enhanced the prospects of the Australian basins. In much of Australia, there was no seismic exploration until about 1958. Subsequently, at least 12 seismic crews have become active. And geologists are seeing their preconceived opinions of the sedimentary basins seriously challenged and extensively modified or discarded in many areas.

Opinion that Australian basins were geologically too old, too shallow, or too stable, are suffering inevitable invalidation in the light of compelling new evidence. Seismic data, borne out by the few deep wells that have been drilled in the past few years and also by expanded geological surveys, are demonstrating that geologically, Australia has much in common with most other oil producing continents.

While exploration is encouraged by geological findings, it also is being spurred by political and economic considerations. Political stability encourages work by American and other foreign as well as domestic interests. A ready market awaits those who can

OIL AND GAS FLOW FROM CABAWIN 1 WELL

(A news report inserted in this article by WORLD OIL editors.)

In early May 1961, Reese H. Taylor, board chairman, Union Oil Co. of California, Los Angeles, confirmed reports that Union and associates had found oil in their wildcat, Cabawin 1, south of Roma, Queensland, Australia. Production tests were still under way.

In 24 hours on May 4, 1961, the well flowed 63 bpd of 51 gravity oil and 386,000 cubic feet of gas through a 20/64-inch choke. Tubing and casing pressures were 1,200 and 1,700 psi, and gas-oil ratio was 6,140.

During six preceding days the well yielded from 71 to 85 bpd through 24/64- to 45/64-inch chokes, with generally lower tubing and casing pressures and higher gas-oil ratios.

Production was from a thin sandstone section of Permian age at about 10,000 feet. A string of 9⅝-inch casing was cemented at 3,051 feet and a string of 5½ landed at 12,033 feet. Total depth of the well was 12,035 feet.

More information about this well appears in the text of this article (Page 152), which was written at an earlier stage of its drilling. The same well previously had a small gas blowout at 9,963 feet, followed by electrical logging that indicated both oil and gas sands in the hole within the Permian section.

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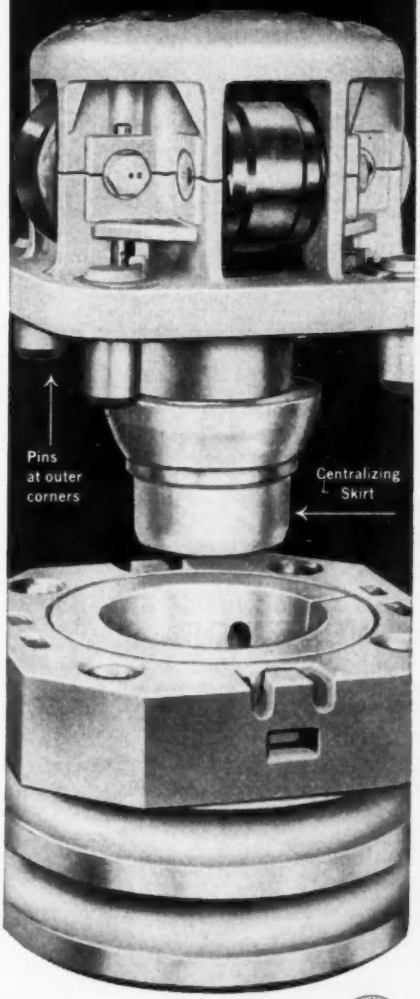

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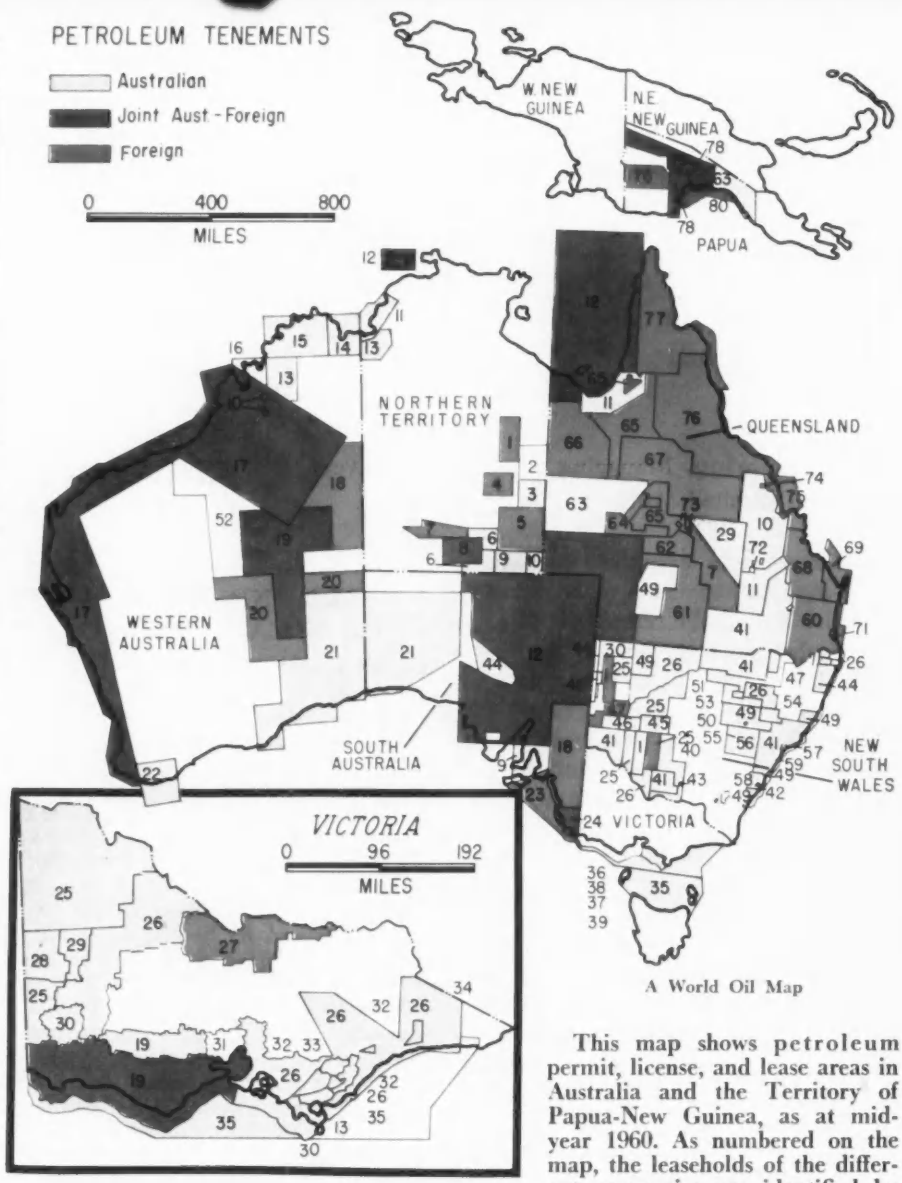


A World Oil Map

MAP OF LEASEHOLDS IN AUSTRALIA

This map shows petroleum permit, license, and lease areas in Australia and the Territory of Papua-New Guinea, as at mid-year 1960. As numbered on the map, the leaseholds of the different companies are identified by this numerical key to the map.

1. Texas American Oil. 2. Texas Australian Exploration. 3. Continental Oil & Gas. 4. Smith Australian Oil. 5. Three States Australian. 6. Flamingo Petroleum. 7. Magellan Pet. Corp. 8. United Canso Oil & Gas. 9. Geosurveys of Australia. 10. Associated Freney Oil Fields (i).

11. Associated Australian Oilfield (i). 12. Santos (ii). 13. Westralian Oil (iii). 14. Gulf Oil Syndicate. 15. Davis, David Llewellyn. 16. Hawkestone Oil. 17. West Australian Petroleum. 18. Hackathorn Oil. 19. Frome-Broken Hill. 20. Hunt Oil and Placid Oil.

21. Exoil. 22. Jackson Explorations. 23. Australian Pacific Oil. 24. General Exploration of Australia. 25. J. G. Fuller. 26. Woodside (Lakes Entrance) Oil. 27. Seismic Analysis. 28. Dome Oil & Minerals Synd. 29. Ian McFarlane. 30. Oil Development (ii, iii).

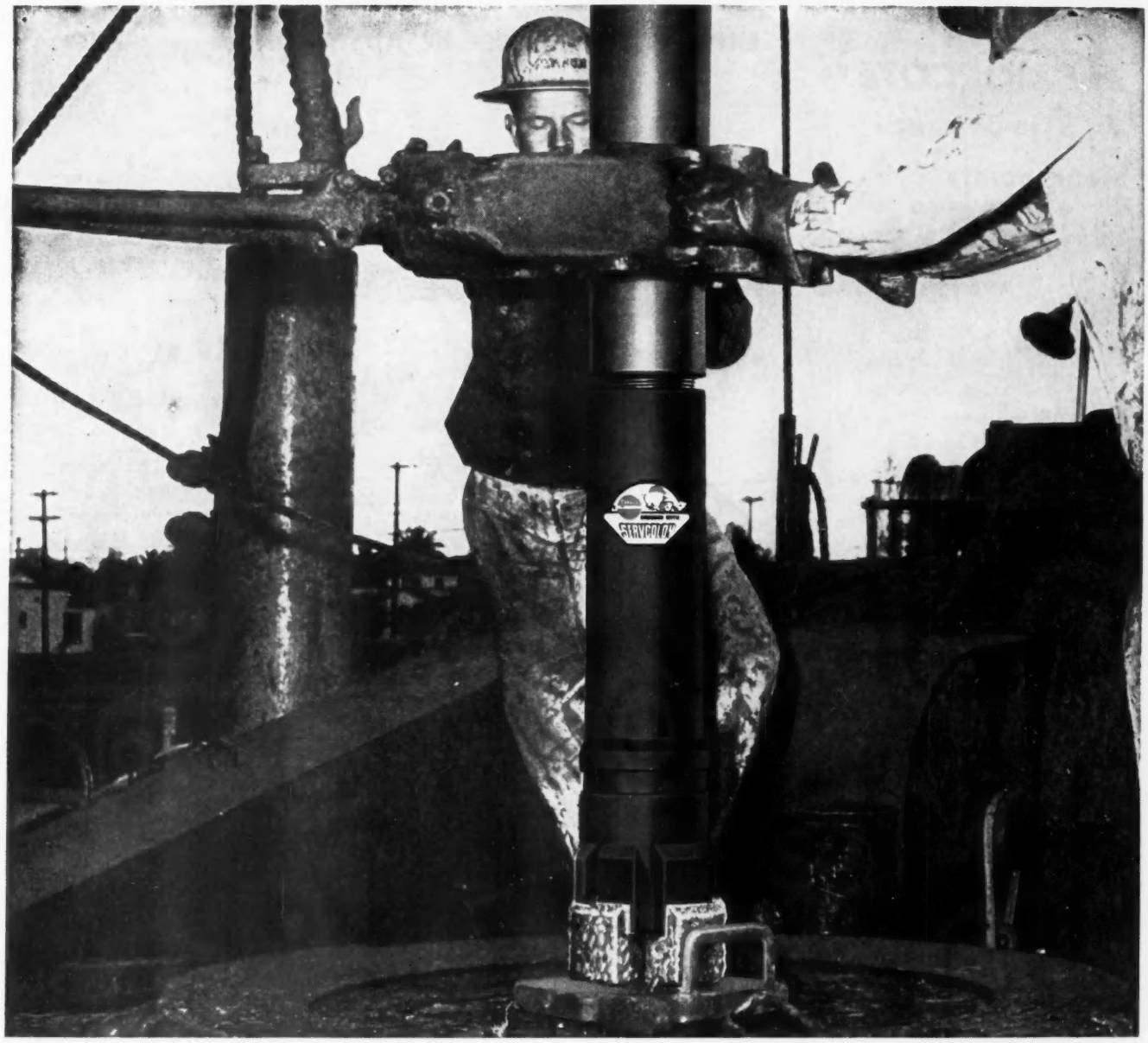
31. Rio Tinto. 32. Victorian Oil. 33. A. P. M. Development. 34. Estate of E. A. Ekberg. 35. Broken Hill Pty. Co. 36. W. M. Westley. 37. S.P.J. Adams. 38. J. A. Adams. 39. W. M. Adams. 40. Landa Australian Oil.

41. Australian Oil & Gas Corp. (iv). 42. Consolidated Oil. 43. C. J. Ellis. 44. Clarence River Basin. 45. Exploration Drilling of Australia. 46. North Australian Petroleum. 47. Sterling Australian. 48. Harver Corp. 49. L. H. Smart Oil Exploration. 50. J. C. Reynolds.

51. Lee Evans Australian Petroleum. 52. Australian Oil Industries. 53. R. Walton. 54. E. Gulliver. 55. M. A. Morandini. 56. A. J. Wood. 57. P. E. Gauld. 58. Australian Iron & Steel. 59. J. Strevens, R. Walton & M. Olarenshaw. 60. Queensland American Oil (vii).

61. Sunray Mid-Continent Oil (v). 62. Cardillera-Australian Petroleum. 63. Papuan Apinaipi Petoleum (i). 64. Conorada Pet. Corp. 65. Carpentaria Oils. 66. Australamerica Corp. 67. Artesian Basin Oil. 68. Nortex Australian Oil. 69. Pacific American Oil. 70. Planet Exploration.

71. Standard Gas. 72. Condamine Oil. 73. Longreach Oil. 74. W. C. and H. J. Walz. 75. Reef Oil. 76. Triton. 77. Plymouth Oil. 78. Island Exploration. 79. Australasian Pet. Co. 80. Camelot Nominees.



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Servcoloy-dressed Junk Mills chew up bit cones and other junk with amazing speed; makes this method of removing a fish fast, safe, and very economical.

After three cones from a 6⅛" bit were left on bottom, two rock bits, two hydro-bailers, and two junk baskets were run during a three-day period in attempts to either recover or sidetrack the three cones. Results were negative.

A six-inch Servco CJ Junk Mill dressed with Servcoloy, was then run in the hole. A total of two feet of hole was drilled in a period of two hours of milling. The operator ran back with a bit and proceeded to drill a head. Fine steel cuttings were caught on the shaker during the milling and appeared on the mud screen during the succeeding day, showing that the *cones were actually milled up, not sidetracked.*

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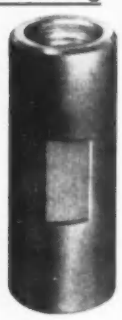

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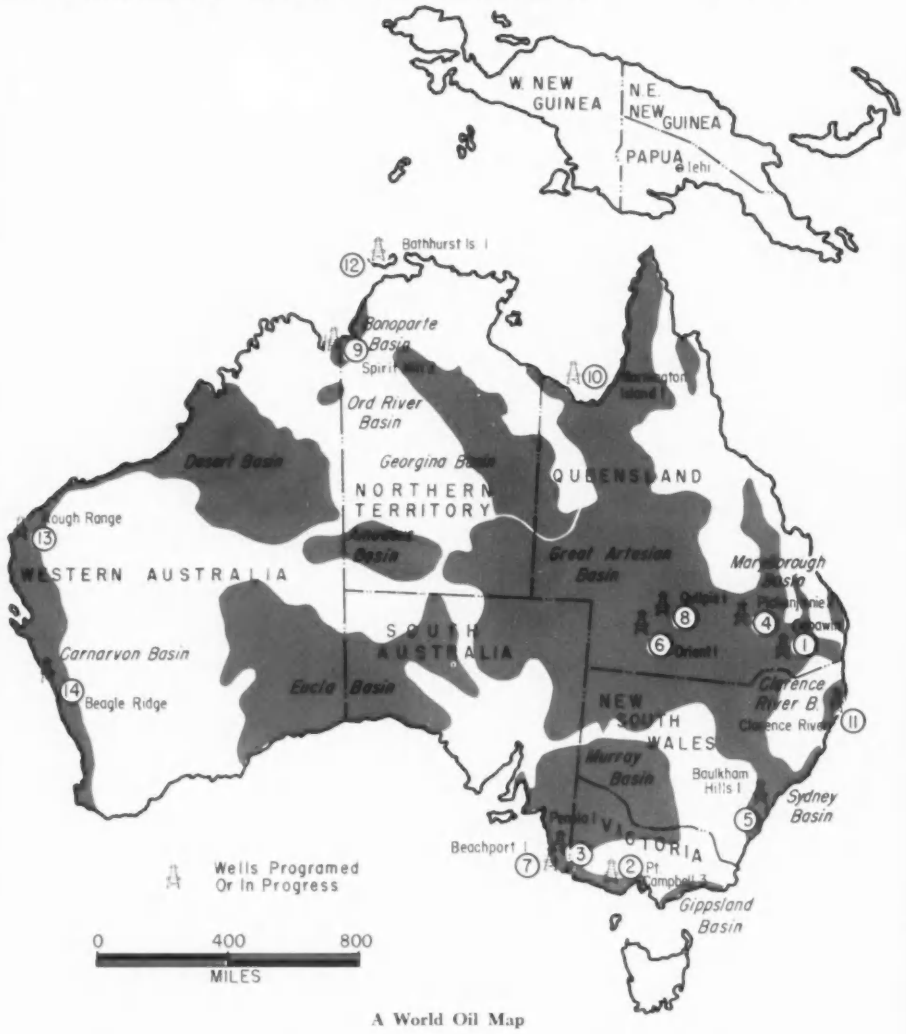
EXPLORATION BOOM IN AUSTRALIA

starts on page 143



A World Oil Map

find and produce Australian petroleum because of the country's lack of its own oil and its need to import large quantities. Australia used 220,000 barrels daily in 1959, and is expected to need twice that amount within 8 to 9 years, as consumption is increasing sharply. Australian oil is urgently needed to assure national security, to help balance foreign trade, with imports exceeding exports, to foster new industries, to stimulate the economy generally and to promote development of needed highways.

Although Australia still is without commercial oil or gas, some definite progress toward production has been made. Oil or gas indications were found prior to 1940 at Roma, Queensland, and Lakes Entrance, Victoria, although few deep wells were drilled and no seismic survey was made before 1950. Thereafter, geological mapping by the Commonwealth government led to the first scientific oil exploration in Western Australia by the WAPET group (Caltex and Ampol). WAPET in 1953 struck the first potentially commercial oil on the continent. A well in the Rough Range area flowed 1,680 bpd of heavy paraffinic crude through ¾-inch choke from thin basal Cretaceous (Birdsong) sands at 3,600 feet. Unproductive offset tests indicated a pool of less

Current Exploration in Australia

This map shows wells drilling or planned in Australia as of February 1961. As numbered on the map, the wells are here identified.

Key Number on Map; Well and Number	*State	Operator
Drilling		
1. Cabawin 1	Q.	Union-Kern-A.O.G.
2. Pt. Campbell 3	Vic.	Frome Broken Hill.
3. Penola 1	S. A.	Oil Development (farm-out from Gen. Ex. Cal. & Santos).
4. Pickanjinnie 2	Q.	Assoc. Aust. Oil and A.F.O. -Papuan.
5. Baulkham Hills 1	N.S.W.	Australian Oil & Gas.
6. Orient 1	Q.	L.H. Smart Oil Corp.
Programed		
7. Beachport 1	S. A.	Gen. Ex. Aust.
8. Quilpie (?) 1	Q.	Phillips-Sunray.
9. Spirit Hill 2	W. A.	Oil Dev. N. L. (? relocation).
10. Mornington Isl. 1	Q.	Delhi-Santos.
11. Clarence River	N.S.W.	Clarence River Basin Oil Co.
12. Bathurst Isl. 1	N.T.	Oil Development N.L.
13. Rough Range	W.A.	WAPET.
14. Beagle Ridge	W.A.	Bureau of Mineral Resources.

* State names are abbreviated as follows: N.S.W., New South Wales; N.T., Northern Territory; Q., Queensland; S.A., South Australia; Vic., Victoria; W.A., Western Australia.

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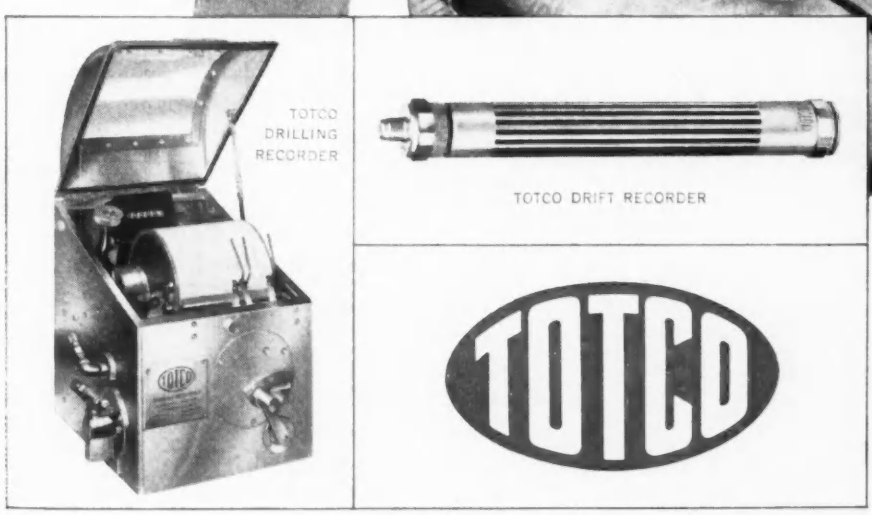

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AIR FRANCE CARGO

starts on page 143

than 50 acres. The company moved operations into the Kimberleys, far to the northeast. Several wells there had showings, and small amounts of oil were produced at Meda. The company only now is returning to the Rough Range area. Further drilling probably would yield significant discoveries in these incompletely tested, enormous areas.

Numerous anticlines were discovered in the Great Artesian Basin of eastern Australia about 1958 by Santos Limited, with Dr. A. I. Levorsen, geologist, Tulsa, as consultant. Those discoveries led to a new era of leasing, advent of numerous American companies, and commencement of the present vital new phase of Australian exploration. Much promising development is now projected, though drilling so far has been limited mainly to the joint efforts of the Santos-Delhi-Frome group. The latter is principally an association of B. P., Stanvac, and Zinc Corporation.

Great Artesian Basin. Covering much of Queensland and portions of New South Wales and South Australia, this is the largest of all Australian sedimentary basins. It is relatively well known in its shallow Mesozoic developments. Deep Paleozoic subbasins converging on it marginally only recently have received more detailed attention as buried prospects. In 1959-1960 two deep, rank wildcats were drilled by Delhi-Santos-Frome on the major Innamincka and Betoota anticlines, near the northeast corner of South Australia, and created great interest.

Unprospective Mesozoic sediments were encountered, with only small showings of oil and gas, and these overlaid possible Proterozoic. It was not until these holes had been completed and the first detailed seismic surveys had been carried out that it was appreciated that these larger anticlines are "baldheaded" at the base of the Mesozoic. Consequently, thick Paleozoic sections in the great intervening synclinal troughs probably rarely carry over the major anticlinal crests. This vital discovery is now being recognized as a principal key to exploration in the Great Artesian

starts on page 143

Basin. It undoubtedly has been recognized by Phillips Petroleum and Sunray Mid-Continent and others operating farther east.

Similar geological conditions hold for several hundreds of thousands of square miles in this great basin. Deeply buried and bituminous Cambro-Ordovician sequences, many thousands of feet in thickness, along with thick Devono-Carbonifierous sections, are now predicted to be present in the Pre-Mesozoic synclinal areas throughout much of this great province. A new impetus is being given to exploration in this vast and still little known basin. The search for lateral or secondary anticlines in the "synclinal" troughs now is under way with growing promise. A number of companies have recognized this new element almost simultaneously, with the regional application of seismic technique. Another stimulating possibility concerns indications of wider developments of marine Permian in the deeper trough zones in much of the central west Artesian Basin.

Permian sub-basins about the eastern margin of the Great Artesian Basin. The Associated Australian Oilfields NL and partners operating in the Roma district, Queensland, introduced seismic techniques into these areas for the first time only in 1960, despite the discovery of condensate gas at Roma in 1900. Seven structures not visible at the surface were outlined. Subsequently, two were drilled in 1959-1960, and yielded petroliferous gas flows up to 9 million cubic feet per day. Source rocks of Permian age were clearly indicated and the work of testing additional anticlinal structures is proceeding. (WORLD OIL, April 1961, Page 101). The structures are mostly baldheaded at the base of the Permian.

At this stage, Union Oil Company of California, with Kern County Land Company as partner, took over exploration from Australian Oil and Gas Corporation on its leases in the Thallon sub-basin (of the Great Artesian Basin) immediately south of Roma. Six months of seismic exploration led to drilling of Cabawin 1 in an area designated as the Surat Basin. At

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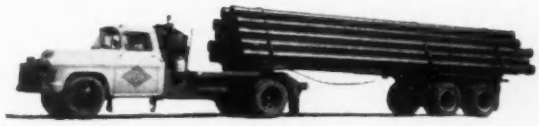

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9,963 feet the well had a small gas blowout. Electrical logging was believed to confirm the presence of both oil and gas sands in the hole within the Permian. In early spring 1961, the well was drilling ahead in shale and sandstone at 11,780 feet.

(Editor's Note: Cabawin 1 of Union Oil and associates flowed 90 to 150 barrels of oil or condensate and 3 MMcf of gas per day while testing in early May 1961 at 12,035 feet. For more information about this significant development, see the special report in the box on Page 143.)

This Cabawin discovery has given impetus to sound thinking by more progressive geologists. It now is conceded that marine Permian may extend widely beneath the deeper Great Artesian Basin and offer promising source bed materials along with the better known earlier Paleozoic formations. Investigations by the South Australian Government Geological Survey have revealed only very recently that much of the Permian about the western Great Artesian Basin also is marine and not entirely continental, as earlier believed.

Southern Coastal Basins. Known deep Tertiary sedimentary basins along the southeast coast of Australia, in Victoria and South Australia, have figured prominently in the search for oil for a number of decades. Much of the earlier reconnaissance interest had been by American companies. But despite this, few deep wells ever went down in these extensive basins, except about the shallow "residual dead oil" finds of Lakes Entrance in eastern Victoria.

The deep Nelson bore in extreme southwestern Victoria put down by the Commonwealth Government at the beginning of World War II went to 7,305 feet. Geological control was poor, and despite extensive coring, much valuable information never was recorded. Generally the deeper section was described as continental early Tertiary sediments, and the deep information did nothing to stimulate new interest. In recent years paleontologists of the South Australian Geological Survey and the C.S.I.R.O. recognized marine Cretaceous in the deeper cores and subsequently also in other bores in this vicinity (Gambier-Portland Basin).

New information concerning sedimentary depths and structure was given in 1959 when the seismic technique was introduced in the area for the first time by Frome B. H. Co. (Vacuum Oil Co., B. P., Zinc Corp., and Interstate Oil). Signs of oil were noted in 1959 in deeper marine Upper Cretaceous sediments in a water bore drilled by the Victorian Mines Department at Timboon. Frome Broken Hill Co. then drilled a well at Port Campbell, south of Timboon, on the nearest high along the single regional seismic traverse in the area. A 4½ million cubic feet per day wet gas discovery was made in the marine Cretaceous. But the reservoir proved to be limited. However, the existence of excellent source bed type marine

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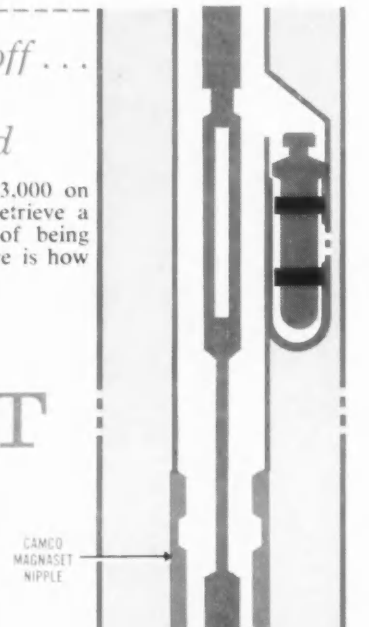

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black shales was proven. And a subsequent deep stratigraphic (off structure) test has extended the information relating to these beds. Wells 3 and 4 will be the first wells adequately planned (seismically) in these extensive deep sedimentary basins, where surface features bear little relationship to structure in depth.

Across the border in South Australia, Oil Development NL in early 1961, commenced drilling a 5,000 foot test at Penola. It was on a farm-out from General Exploration Company of California and Santos Limited. Deep anticlinal structure had been demonstrated seismically. It was the first adequately located well in this basin, other than the current tests at Port Campbell.

Seismic exploration came to other coastal Tertiary basins in eastern Victoria for the first time in 1960, and also around Torquay. The new geological key to these areas appears definitely to be marine Cretaceous wedging out from under the continental platform. Structure is also better developed than previously predicted in these areas.

Northern Coastal Basins. Global researches by Russian geologists direct particular attention to the Gulf of Carpentaria in northern Queensland, northeastern Australia. American researchers have reported comparable conclusions. The basin so far has proved less than about 3,000 feet deep in eastern developments, where it already has been drilled on several sites. Particular interest now centers on the Delhi-Santos well scheduled for mid-1961 on Mornington Island. Attention stems in part from the marginal relationships of these basin developments with the Papuan-Timor-Sumatra geosynclinal belt, in which seepage indications of oil are so widespread, and in which oil and gas strikes have been made recently in Timor.

In a comparable category is the Bonaparte Gulf, in which seismic survey activity and drilling by Oil Development and Associated Australian Oilfields have verified deep Paleozoic sections and promising structure. In 1961 there will be deeper drilling by Oil Development on the Spirit Hill anticlines.

Disappointment in exploration in Papua, on the island of New Guinea, off northern Australia, must relate extensively to extremely high costs, the world oversupply of oil, and political uncertainties. Suspension of activities by the two major partners in Australian Petroleum Co. is not due to geological factors. All five recent holes drilled by this company had produced promising flows of oil and gas.

The island of Timor northwest of Australia, also recently recorded its first oil discovery at Matai. Details of testing were awaited, but it was clear that the island had definite potential.

Current Drilling. In the spring of 1961, considerable drilling was in progress or planned. Six wells were drilling, being numbered here as on the accompanying map.

1. Cabawin 1 of Union-Kern-A.O.G., south of Roma, Queensland, was drilling at 11,780 feet after testing Permian oil and gas sands at 9,963 feet.

(Editor's Note: In early May 1961 Cabawin 1 was testing at 12,035 feet total depth, flowing 90 to 150 barrels of oil or condensate and 3 MMcf of gas per day. A special report on this important testing appears in the box on Page 143.)

2. Port Campbell 3 and 4 of Frome Broken Hill in southwestern Victoria were due to test Cretaceous wedge-outs on anticlinal structures. No. 3 was drilling and No. 4 was a location. Cretaceous sands in Port Campbell 1 wildcat produced a flow of 4½ million cubic feet of petroliferous gas per day.

3. Penola 1 of Oil Development, on a farm-out from Santos and General Exploration Co. of California, in southeastern South Australia, was to be the first test in the deep Tertiary Mesozoic Penola "trough."

4. Pickanjinnie 2 of Associated Australian Oilfields N. L. and associates was drilling east of Roma, Queensland. The operators projected this and other tests of Permian petro-

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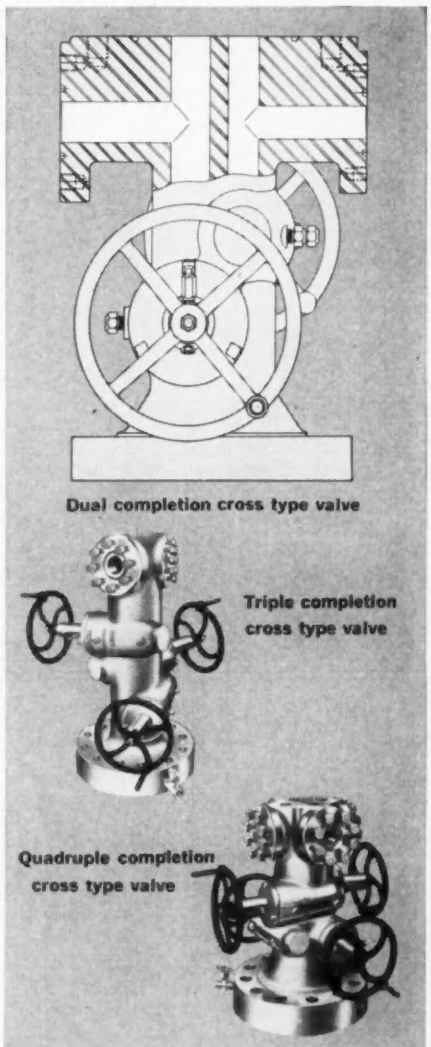

W-K-M DIVISION
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liferous gas sands in seismically located structures in the area. Pickanjinnie 1 in 1960 flowed 6½ million cubic feet of gas per day (WORLD OIL, April 1961, page 101).

5. Baulkham Hills 1 of Australian Oil and Gas was being drilled in New South Wales.

6. Orient 1 of L. H. Smart Oil Corporation was being drilled in Queensland in the Great Artesian Basin.

Eight other tests were definitely planned. They are also numbered here as on the map.

7. Beachport 1 was planned by General Exploration of Australia in South Australia.

8. Phillips-Sunray planned to begin drilling in early spring of 1961, in a 16,000 foot test of a buried Paleozoic anticline north of Quilpie, Queensland, in the Great Artesian Basin.

9. Oil Development contemplated deepening or relocating Spirit Hill 1 in the Bonaparte Gulf, northwestern Australia, to test Devonian possibilities of the Spirit Hill anticline.

10. Mornington Island 1 of Delhi-Santos was planned as in intermediate deep test of the Mornington Island structure in the Gulf of Carpentaria, Queensland. Russian researchers recently stated they considered the deeper parts of this gulf a promising oil prospect on the basis of global geology.

11. Clarence River Basin Oil Company planned to drill in the eastern coastal Clarence Basin, northeastern New South Wales.

12. Oil Development N. L. projected Bathurst Island 1 near Darwin, Northern Territory, and northeast of the company's Spirit Hill development.

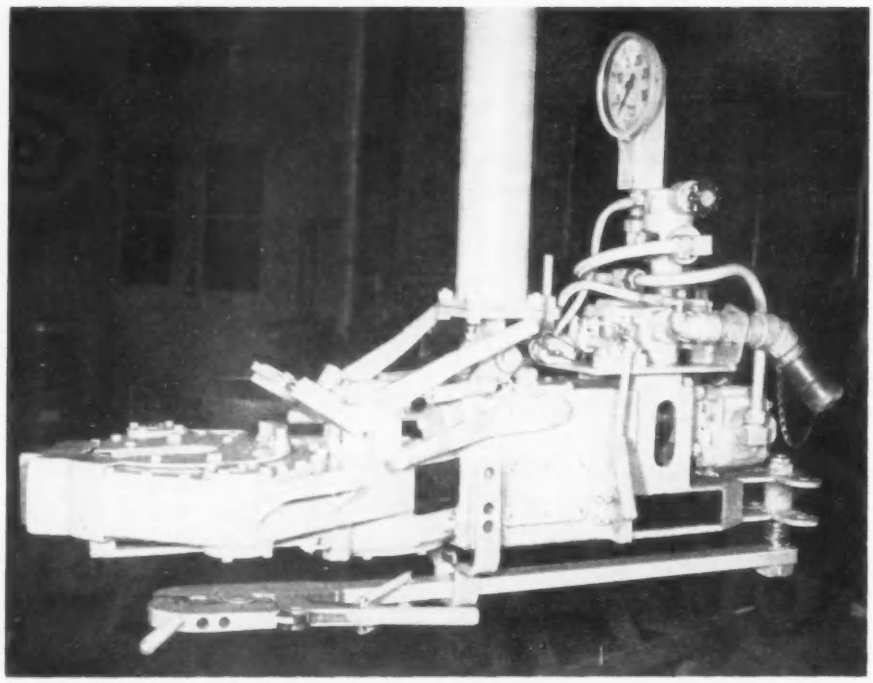
13. Further drilling is contemplated by WAPET in the Rough Range area, Western Australia. From a well in the area 1,680 bpd of heavy, paraffinic crude flowed through a ¾-inch choke in 1953.

14. Additional drilling was planned on Beagle Ridge in the Perth Basin, Western Australia, to the south of Rough Range, by the Bureau of Mineral Resources. Promising showings of oil were encountered there above 4,000 feet in 1960.

• Further exploration was planned for Papua by Oil Search Ltd., and associates, B. P. and Vacuum Oil. The latest five wells drilled there all encountered promising flows of oil (Puri 1) or gas (Barikewa, Kuru, Bwata, and Iehi).

• Testing proceeded at Matai 1, Timor Island, where oil sands were encountered at 800 feet by Timor Oil and Tradewinds Exploration.

Other basins, such as the St. Vincent Gulf near Adelaide, South Australia, remain untested, but also had their first seismic exploration in 1960. Deep drilling soon will follow. Everywhere these basins are investigated scientifically, they prove to be deeper



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starts on page 143

About the Author

R. C. Sprigg is managing director of Geosurveys of Australia Limited, a geological and geophysical consultant firm. Born in South Australia, he graduated as master of science from the University of Adelaide. He is A. M. Aus. I. M. M., M. Am. A. P. G., and M. G. S. Am. After employment in the Soil Division and the Geological Survey of South Australia, he studied uranium mining overseas for the South Australian Government beginning in 1948. In 1954, he formed Geosurveys (Australia) Limited, a geological consulting organization which has since expanded into geological, geophysical and mining contracting.

and geologically more promising than previously predicted. More deep tests are needed.

Other Eastern Australian Basins. The Sydney (New South Wales) and Maryborough (Queensland) Basins of the extreme eastern coastal regions are also due to receive more scientific investigation. Seismic exploration is planned in the Sydney area for the first time in 1961. Union Oil Co. of California and Kern County Land's participation with Australian Oil and Gas Corp. in exploring deeper Paleozoic developments in these areas will be a decisive new factor.

The Murray Basin, New South Wales and South Australia, still lacks real effort, although the Bureau of Mineral Resources carried out limited reconnaissance seismic work late in 1960. Hackathorn Oils Ltd., completed a single traverse in the South Australian area, near Loxton, and may have defined deeper sedimentation. Much remains to be done to provide even the most elementary appreciation of the geology of much of this basin. —**The End**

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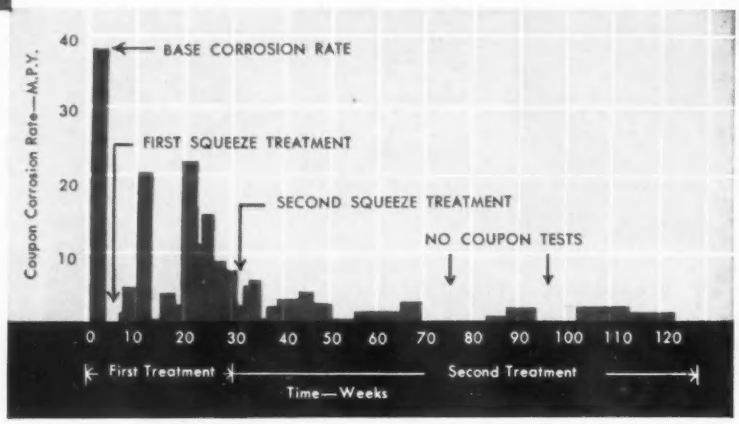

Corrosion history of a West Texas well, showing coupon corrosion rate with time

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Inhibitor squeeze treating began by pumping a mixture of 30 gallons of KONTOL dispersed in 100 bbl. of crude oil into the formation through the casing-tubing annulus. This was followed by a 100 bbl. crude oil overflush. Surface pressure was approximately 1,000 psi during the squeeze. Following this treatment, the well was closed for 20 hours.

KONTOL *results are positive*

During the first five months following treatment, the corrosion rate varied from a high of 21 m.p.y. to a low of 0.5 m.p.y. For 11 weeks of this period the rate was below 5.0 m.p.y. No equipment failures due to corrosion were reported during the five-month period.

KONTOL *protection is long-lasting*

Six months after original squeeze treatment the corrosion rate was still satisfactory, but it was decided to resqueeze the well to make certain of uninterrupted protection. During the following 90 weeks, coupon tests showed a corrosion rate that averaged 2.0–3.0 m.p.y.—proof of KONTOL's enduring effectiveness.

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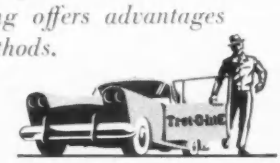

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Your industry at work

A monthly roundup of items of interest about people, companies and associations

Oil Men Honored by API Mid-Continent District

H. A. Nedom, Amerada Petroleum Corporation (second from left), and Herbert M. Cooley, Bethlehem Steel Company, received "Citations for Service" awards for outstanding service to the petroleum industry and to the API Division of Production at the recent spring meeting of the API Mid-Continent District. Gage Lund, vice president of Standard Oil Company of California and API vice president for production, presented the awards. A third recipient was Fred V. Kluck, The Ohio Oil Company, who was unable to be present for the award presentation.

Bolivia California Acquires Alaska International Properties

Bolivia California Petroleum Company, a subsidiary of Standard Oil Company of California, and Compania Petrolera Boliviana Shell, Limited, have acquired by assignment from Alaska International Corporation five petroleum concessions covering 114,750 hectares in Petroleum Zone 1 in Bolivia.

The concessions are located approximately 50 kilometers east of the City of Santa Cruz and are adjacent to other concessions held by the two companies on which a well is now being drilled.

South Penn and Zapata Form New Exploratory Venture

South Penn Oil Company of Oil City, Pa., and Zapata Petroleum Corporation, Midland, Texas, have formed a new operation for the purpose of developing gas production in Canada and to purchase producing properties in the Southwestern and Midcontinent areas of the United States. The venture will be particularly interested in the acquisition and development of water-flood and other secondary recovery prospects.

Under the terms of the agreement, South Penn is acquiring a one-half interest in Zapata Canadian Petroleum Corporation which presently owns approximately 185,000 acres of partially developed gas leases in Western Canada. It is anticipated that in excess of twenty development and exploratory wells will be drilled by Zapata Canadian during the current year.

South Penn and Zapata will participate in the ownership of future property acquisitions in the area of joint interest on an equal basis. Properties presently owned and operated by both organizations will not be affected by the new venture.

Oilwell Research Incorporated Acquires Lampkin Laboratory

Charles C. Wright, president of Oilwell Research, Inc., of Long Beach, Calif., has announced the acquisition of Lampkin Laboratory of Bakersfield, Calif. Both companies are specialists in drilling and production problems, core analysis, corrosion and water testing.

The Bakersfield branch will continue under the direction of Robert E. Lampkin, who recently resigned from his position as vice president and general manager of Petroleum Technologists, Inc., to start the new venture.

Merit Shareholders Approve Sale of Assets to Husky Oil

Glenn E. Nielson, president of Canadian Husky Oil Ltd., and Clifford R. Walker, vice president of Merit Oil Ltd., have announced that the agreement for the purchase by Canadian Husky of substantially all the assets and undertakings of Merit Oil has been finalized. The shareholders of Merit Oil approved the agreement at an extraordinary general meeting held in Calgary recently.

In addition to accounts and notes receivable of approximately $1,750,000, Merit's interests in four producing oil wells and certain leases, reservations and royalties, Canadian Husky will acquire all of the issued shares of Provincial

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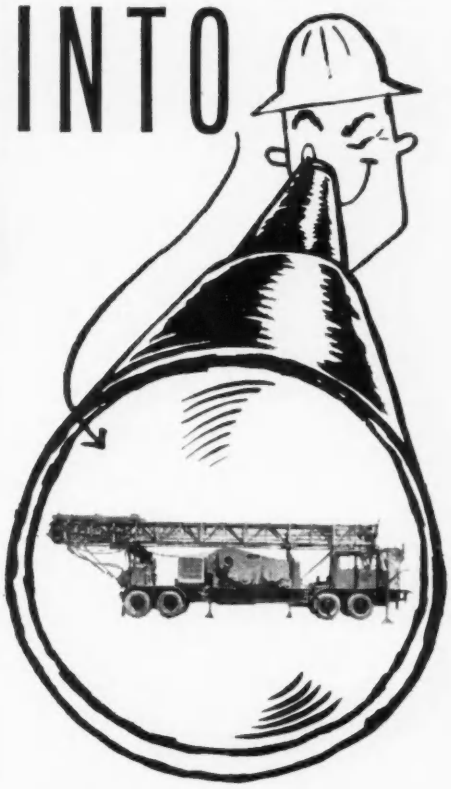

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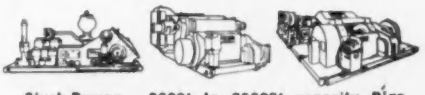

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Your industry at work

Products Pipelines Limited, whose application to construct a gathering system for natural gas liquids in the Province of Alberta is now before the Oil and Gas Conservation Board.

In consideration, Canadian Husky will assume liabilities of Merit of approximately $500,000 and will issue to Merit Oil Ltd., 50,000 common shares and warrants for the purchase of an additional 390,000 common shares of Canadian Husky Oil Ltd., at $14 per share; exercisible on or before December 14, 1964. Merit has agreed that it will not sell any of the common shares or stock purchase warrants for a period of six months after the effective date of the agreement.

Ohio Oil to Reorganize Three Domestic Production Divisions

A reorganization of three domestic production divisions of The Ohio Oil Company, involving 14 states in the South, Southwest and Mid-West, has been announced. The change will become effective by September 1.

The realignment will consolidate the Tulsa and Shreveport, La., Division offices, with the expanded headquarters to be in Tulsa. It also brings about changes in the territory under the jurisdiction of the Houston Division.

The enlarged Tulsa Division will include all of Oklahoma, Kansas, Missouri, Iowa, Arkansas, Alabama, Mississippi, North and South Carolina, Georgia, Florida, as well as East Texas. It will also include all of Louisiana with the exception of the Gulf Coast and offshore areas, which will come under the Houston Division. The Texas Panhandle territory will be added to the Tulsa Division.

The Houston Division will continue to be responsible for the remainder of Texas and all of New Mexico but the northwest corner.

W. B. Berwald, Shreveport division manager since 1953, will become manager of the Tulsa Division. J. S. Leonard, manager of the present Tulsa Division since 1955, will go to the Ohio Oil general office in Findlay, Ohio, about January 1 to assume an executive assignment in the domestic production headquarters. A district production office, staffed by operating, engineering, geologic, land and general administrative and clerical personnel, will be maintained in Shreveport.

Houston Engineers Form New Core Laboratory

Reservoir Laboratories, Inc., has recently been formed in Houston by John E. Shelton and William E. Dark, offering a complete range of analytical service.

The new firm will specialize in the development of combination exploration and reservoir engineering core analysis data. Basic analyses will include fluid saturations, porosity, absolute permeability and capillary pressure for connate water determination. Specialized analyses offered by the new firm will embrace gas-oil relative permeability, waterflood evaluations and injectivity tests, residual gas saturation by water displacement and resistivity measurements.

Dark has been a reservoir engineer for Humble Oil & Refining Company in various assignments including three years in Humble's lab at the Houston Research Center. Shelton was supervisor of Humble's core analysis lab for four years. Offices of the new firm are at 3026 Yellowstone at Old Spanish Trail, Houston.

Standard Oil Foundation Awards Four Fellowships

Four one-year doctorate fellowships awarded by the Standard Oil Foundation, Inc., to further the careers of college engineering teachers has been announced.

The number of fellowship awards was increased this year from three to four. Standard Oil Foundation started its doctorate fellowship program in 1958 to help college engineering teachers advance their careers. A total of 13 one-year doctorate fellowships have now been awarded.

The four new grants of funds to finance study toward doctorate degrees were awarded to Robert E. Mates, Cornell University, Ithaca, N.Y.; Jerome L. Novotny, University of Minnesota, St. Paul, Minn.; Lyle H. Schwartz, Northwestern University, Evanston, Ill., and Richard E. Thompson, Oklahoma State University, Stillwater, Okla.

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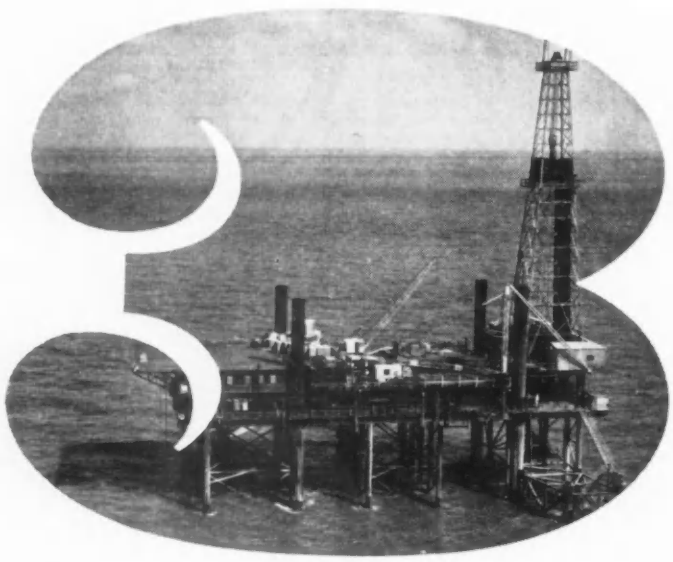

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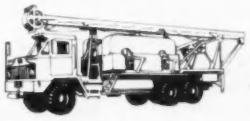
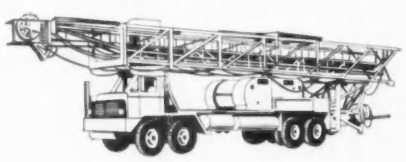
When you're in trouble you look for a friend that you can depend on . . .  just as oil men depend on servicing contractors to keep their wells pumping at top efficiency. And, experience teaches that the most dependable contractor is the one with **good equipment . . .** like Franks . . . equipment engineered and built to keep the contractor as well as the producer out of trouble. **So, next time you are faced with servicing problems, look for** **proven dependability. Ask the man who uses Franks . . .** about the equipment that keeps him out of trouble.



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Men in the industry

Martin A. Row has been appointed as special counsel for Foreign Operations in **Sun Oil Company's** Production Department. Row succeeds to the duties formerly discharged by **John W. Timmins,** who retired the first of the year.

Carl Illig has succeeded **Forrest M. Darrough** as associate general counsel of **Humble Oil & Refining Company,** principal operating affiliate of **Standard Oil Company (New Jersey).** Darrough is now general counsel of Humble. He succeeds **Nelson Jones,** who was elected to the company's board of directors.

George H. Reneau has been appointed manager of production and chief engineer, and **Leonard Swords** has been appointed manager of exploration for **Alco Oil and Gas Corporation.**

E. F. Bullard, Tulsa, and **L. W. Moore,** Chicago, have been elected directors of **Standard Oil Company (Indiana),** by the board of directors. Bullard is chairman of the board of **Pan American Petroleum Corporation,** the wholly owned exploration and production subsidiary of Standard Oil (Indiana). Moore is president of **American Oil Company,** the national marketing and manufacturing subsidiary of Standard Oil (Indiana).

W. E. Avery

Wallace E. Avery has been elected vice president in charge of **Texaco Inc.'s** West Coast operations, effective May 1. Avery, who has been secretary of Texaco Inc., since 1956, will make his headquarters at Los Angeles. **Maury L. Nee,** formerly director of budget, has been elected to succeed Avery as secretary.

Frank C. Bishop of San Francisco, and Midland, Texas, has been elected a director of **North Star Oil Company.** The election took place at the annual meeting of shareholders.

W. J. Greenwald has been named general manager of the Natural Gas Division of **Humble Oil & Refining Company. John J. Carter** has been named manager of the division and will assist Greenwald in handling Humble's natural gas sales.

Irving Senzel has been named lands staff officer of the Bureau of Land Management, **Department of Interior.**

William R. Hewlett, executive vice president and director of the **Hewlett-Packard Company,** has been elected a director of **Kern County Land Company.**

H. J. Shumate has been elected a vice president of **Loffland Brothers Company.** Also, **Edward C. Dorroh** has been employed as contract manager of the Rocky Mountain Division.

William T. Payne has been elected chairman of the board of **Seneca Oil Company.** Other members elected to the board include **Jack H. Abernathy,** president; **Ted C. Findeiss,** vice president-secretary, and **F. E. Godfrey,** treasurer. The new officers are all connected with **Big Chief Drilling Company** and will retain their connections with that corporation.

George M. Parker, president and a director of **Esso Export Corporation,** has been appointed senior representative of **Standard Oil Company (New Jersey)** in London and Jersey shareholders representative for its affiliate companies in the United Kingdom, Norway, Sweden, Denmark and Finland.

Judson Laird has been appointed manager of a newly created community services division of **Sun Oil Company's** Public Relations Department.

Paul H. Weyrauch has been promoted to treasury coordinator for **Gulf Oil Corporation** at Houston.

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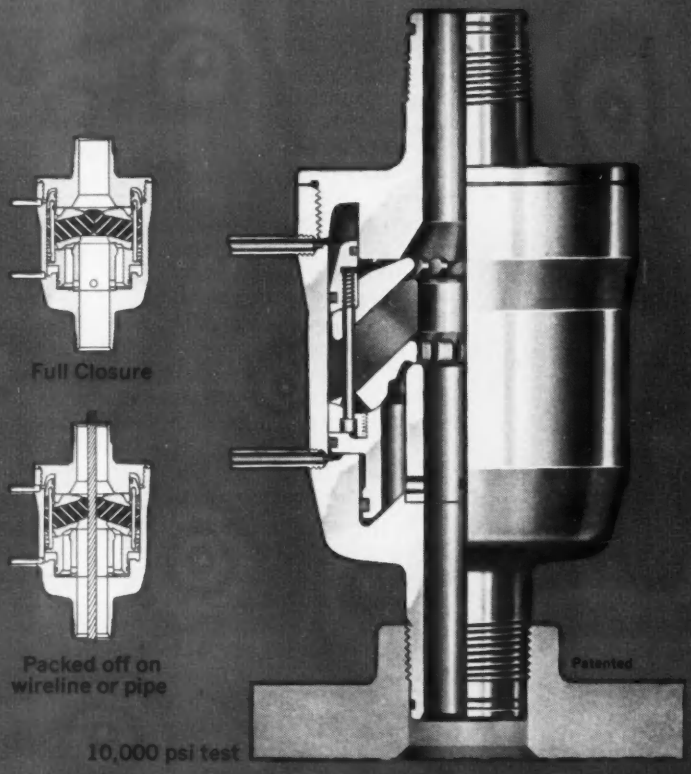

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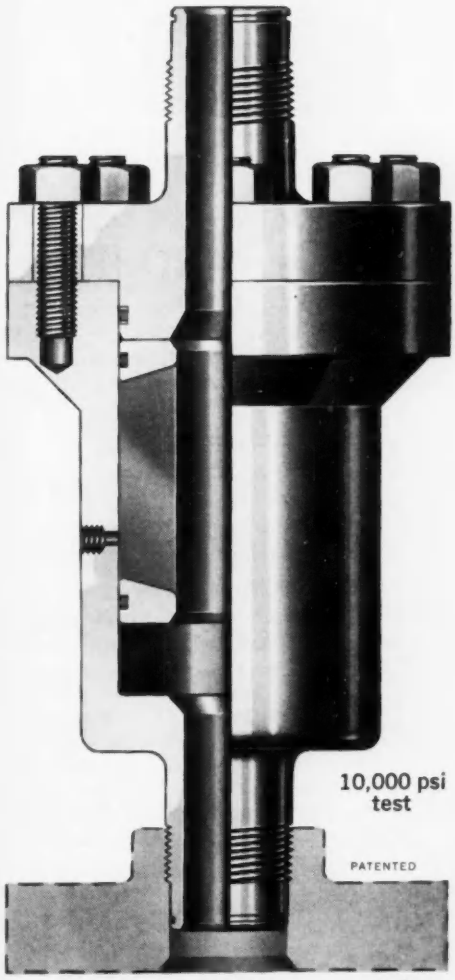

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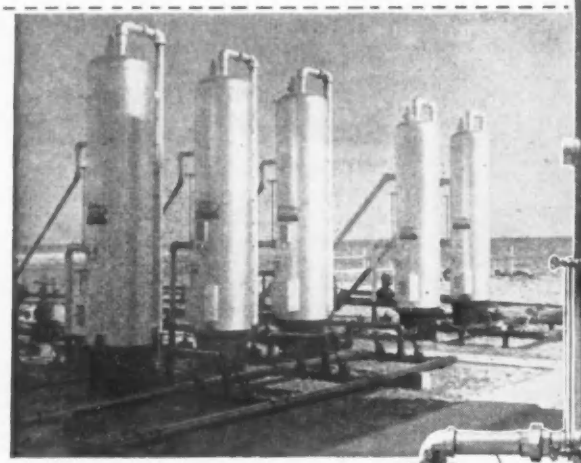

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METROL Metering Separators will separate the oil and gas and will meter the oil. Patented* Snap Acting Liquid Level Control and positive valving sequence assures metering accuracy as high as 99.99%.

Use of METROL Metering Separators is accepted by most regulatory bodies. They are ideally suited for metering oil for royalty and tax payments, for testing wells, producing multiple completed wells into common storage tanks, test separators at tank batteries and Automatic Lease Operation.

Sizes available are 16, 20, 24, 30, 36, 48, 60, and 72 inch diameter with 6′ to 20′ shell lengths in 125, 300, 600, 1200, 1500, 1800, 2000, 2400, and 3000 psi W.P. The units will handle from zero to 20,000 BPD. Dump volumes range from ¼ bbl. to 30 bbls.

*U. S. Patent No. 2,818,738

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We solicit your inquiries.

Every Unit is completely assembled, pressure tested, calibrated, and performance tested prior to shipment.

Competent Sales and Service Representatives located in all major oil areas.

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P.O. Box 10777, Houston 18, Texas

Men in the industry

Dr. Richard F. Neblett and **John R. Tuttle, Jr.**, have been awarded positions of research associates, a post given to men with outstanding technical abilities, by **Esso Research and Engineering Company.**

Walter H. Helmerich, III, president of **Helmerich & Payne, Inc.,** and **Guy R. Mabee,** independent oil man and rancher, have been elected directors of the **First National Bank and Trust Company of Tulsa.**

S. P. Coleman

Stewart P. Coleman, a vice president and member of the board of directors of **Standard Oil Company (New Jersey),** has retired for reasons of health as of April 1. Coleman began his career in the oil business with **Humble Oil & Refining Company,** a Jersey Standard affiliate, as a chemical engineer after his graduation from Rice University in 1920.

Paul E. McGovney has been elected vice president in charge of **Clark Oil & Refining Corporation's** exploration and production division.

Jeff Watts's contract as general manager of **Buttes Gas & Oil Company** has been extended for another four years. The contract is effective through December 31, 1963.

L. F. McCollum, president of **Continental Oil Company,** Houston, has been elected to the board of trustees of the **California Institute of Technology.**

John V. Morgan has been appointed assistant division engineer for **Pan American Petroleum Corporation's** North Texas-New Mexico Division.

John G. Yeager has been named manager of the Crude Oil Department of the **Humble Oil & Refining Company's** Humble Division, succeeding **J. C. Posgate,** recently appointed manager of Humble's Midland, Texas, area. In the Exploration Department of Humble's Southwest Region, **B. R. Payne** has been named acting regional geologist; **H. G. Patrick,** regional geophysicist; **John F. McRae,** regional landman, and **D. C. Fransen,** regional scout. **Dr. Valliant C. Baird** has been appointed to the newly created position of medical director in the headquarters organization.

William B. Bateman and **John A. Pell** have been appointed vice presidents of **The Chase Manhattan Bank.** Bateman is in the petroleum division and Pell is in the New York and New Jersey district of the U.S. Department.

A Visco PRODUCT MANAGER Answers Questions on Clarification for Open System Waterflood and Salt Water Disposal Units

Effective Clarification Lowers Water Treatment Costs, Ups Operating Efficiency

Successful waterflood operation is heavily dependent on good clarification practices to keep injection wells and formations from plugging, raising pumping pressures and cutting input volumes. Here are a few of the most-frequently-asked questions about clarification, and answers which may be helpful to you.

Question: What is the difference between clarification and coagulation?

Answer: Clarification is the process of removing turbidity and finely-divided particles from water. Coagulation is one of the ways to achieve clarification: gathering the finely-divided particles into clumps or "flocs" by means of chemical coagulants to speed settling. Other commonly-used means of clarifying water are filtration and slow settling without use of coagulants.

Question: Do you know beforehand which coagulants will work best in any particular water?

Answer: Generally, no. Coagulation occurs when electrical charges on turbidity particles are neutralized. These charges vary considerably, depending on the characteristics of the turbid water. Chemicals which will form good, dense, heavy floc in one water may be slow-acting and ineffective in another. The best way to be sure that the proper coagulants are being used is to "jar test" a number of coagulant chemicals in the water to be clarified.

Question: What is jar testing?

Answer: Jar testing is a multiple testing of turbid water samples with all known coagulants, singly and in combinations with each other, to determine which coagulants are most effective and economical to use in the specific water.

Product Manager Don Oleen demonstrates jar testing technique used by Visco water injection specialists. It is the sure way to get exact data on the coagulants and coagulant aids best suited in performance and economy for the specific injection water being used.

Don C. Oleen, Product Manager, Visco Waterflood Chemicals Department, is among the best qualified men in the petroleum industry to answer questions and solve problems in waterflood treatment.

Question: When and where should jar testing be done?

Answer: Immediately upon taking the sample, right at the flood where the water is to be treated. Turbidity in water samples used for jar testing coagulants will partially or wholly settle out if samples are not tested immediately. A coagulant which appears to do a good job on water samples taken hours or days before may be expensive, inadequate, or both when used at the waterflood location.

Question: Can Visco jar test the injection water for my waterflood system?

Answer: Yes. All Visco water injection specialists are equipped and trained to run jar tests at flood or salt water disposal locations . . . And this service is available *only* from Visco.

Question: What about the time and costs of jar testing?

Answer: Jar testing is a Visco service, provided without charge by Visco water injection specialists. A phone call or letter to your Visco Representative will bring a specialist to make jar tests and give you recommendations as to the coagulant chemicals which will do the best clarification job at lowest cost on your injection water. Time to call Visco is now.

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Visco® ... consistently efficient oil field chemicals

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THE RUSTON 'TE' SKID-MOUNTED GAS TURBINE ALTERNATOR SET
is light and completely self-contained.
Weighing only 16,750 lb this long-life air-cooled unit can be moved around—fast! Off the truck, on to the ground, connect the fuel. That's all. You've got 300 kW ready to work for you non-stop . . . and ready to move on anytime.
Nothing temperamental about this turbine!
Built as a heavy duty unit with a designed blade life of 50,000 hours, it's proving as dependable as the Ruston 'TA'.

The Ruston 'TA', the 1260 b.h.p. turbine with the longest and finest record in oilfield service, is now also available as a skid-mounted unit. Find out more from Ruston!

RUSTON GAS TURBINES

430 and 1260 b.h.p. at 80°F. ambient temperature

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Men in the industry

George W. Roth has been appointed as director, product procurement and refinery sales of **Gulf Oil Corporation.** He succeeds the late **N. C. (Cal) Loomis** and will headquarter in New York.

R. L. Meadows, formerly superintendent of operations, has been elected vice president in charge of operations for **Movible Offshore Company,** Houston.

William Grant

C. N. Bailey

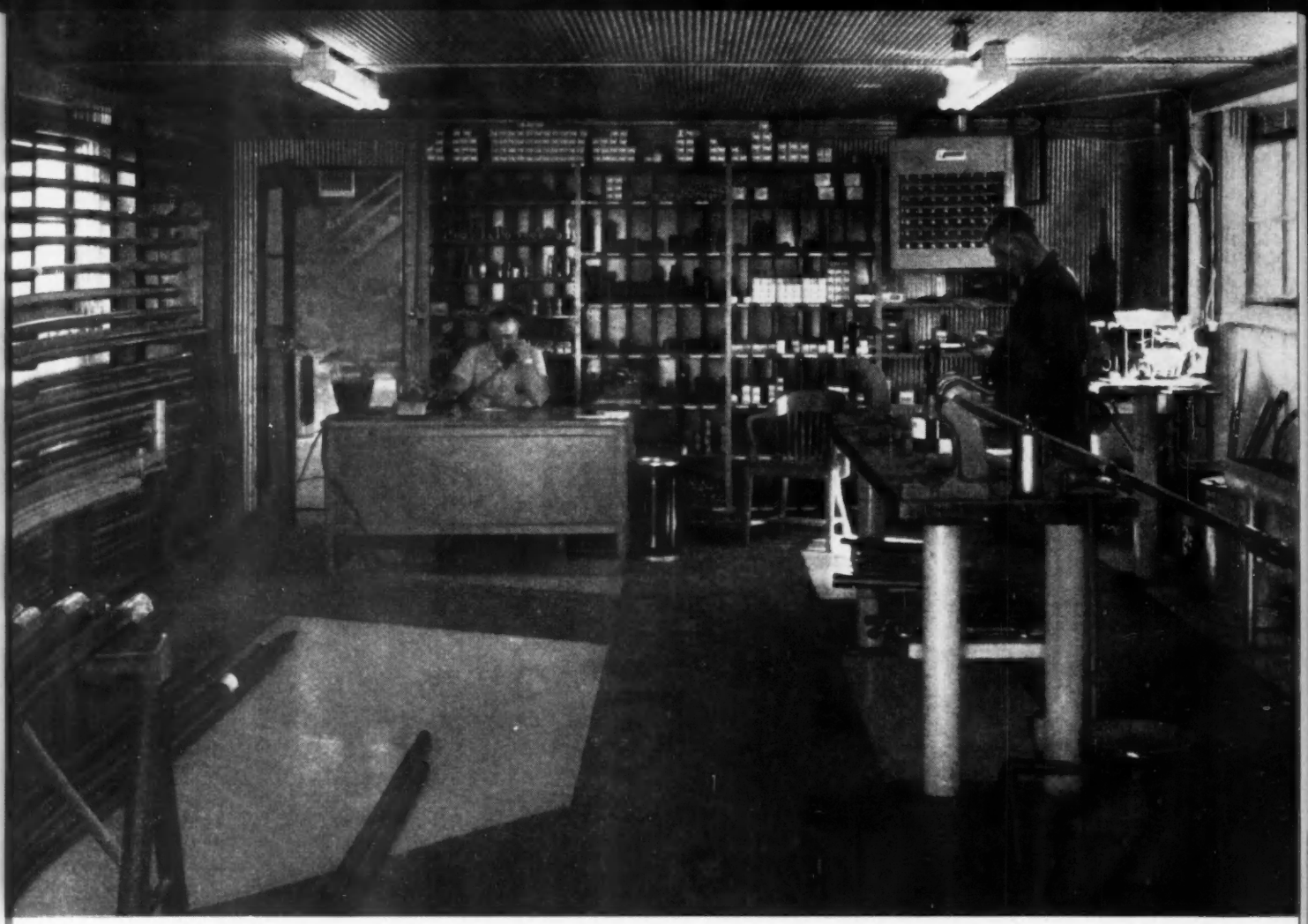
O. L. Furse, who has been serving as eastern area production manager of the Humble Division for **Humble Oil & Refining Company,** has been named regional production manager; **E. A. Murchison, Jr.,** serving as eastern area exploration manager, has been appointed regional exploration manager; **E. M. Jolly,** serving as manager of the Tennessee-Arkansas area of the Esso Standard Division, has been appointed regional marketing manager; **C. N. Bailey,** serving as assistant controller of the Humble Division, has been appointed regional controller; **William Grant, Jr.,** serving as assistant manager of the Employe Relations Department, has been appointed employe relations manager; **Charles Janvier,** serving as area attorney for the eastern area of the Humble Division, has been appointed regional general counsel, and **A. F. Kent,** serving as information division head in the Public Relations Department of the Esso Standard Division, has been appointed regional public relations manager. **Fred W. File,** Humble's Billings, Mont., area attorney, has been named associate regional counsel at Tulsa. **John D. Knodell, Jr.,** replaces File at Billings. **Albert C. McClain** replaces Knodell at Mattoon, Ill., as company area attorney.

A. B. Dyes has made an agreement with **Geopetrole of Paris** wherein he will be a full-consultant in Paris, France, on a long term basis. Dyes formerly was supervisor of reservoir engineering with The Atlantic Refining Company.

A. M. Laurie and **Robert W. Mannor** have recently formed **Laurie & Mannor Petroleum Consultants** in Modesto, Calif.

K. N. Burns has been named section head in charge of basic geophysical research by **Jersey Research Production Company.**

Claude E. Peavy has retired from his position as executive vice president and general manager of **Britalta Petroleums Limited** of Calgary, Alta.



Where pumps are pampered

Repair service for subsurface pumps is a Bethlehem specialty

Bethlehem pump shops are staffed with experts—men with practical experience in the repair and operation of subsurface pumps. Every one of our shops has complete repair facilities and a full stock of replacement parts. Bethlehem pump experts can quickly diagnose the ills of any troublesome or worn-out pump. And they can put it back into top shape in a hurry.

Select a Beeline pump from our complete line

Bethlehem's the place to shop for new pumps, too. Our popular *Beeline* series of subsurface precision pumps includes one which will meet your needs exactly, whatever the condition of your well. Each *Beeline* pump is engineered to the same high standards which characterize all Bethlehem equipment.

Whether you need a new pump or repairs on a used one, check with a Bethlehem pump shop. You'll find one near you.

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Supply Division
General Offices and Export Dept.: 21 East Second St., Tulsa, Okla.

BETHLEHEM STEEL

BETHLEHEM STEEL SUPPLY DIVISION

Men in the industry

W. L. Butte has become a deputy regional coordinator for **Standard Oil Company (New Jersey)** and Jersey Standard's London Middle East representative. Butte succeeded **Paul J. Anderson** who is to be nominated as a candidate for the Jersey board. Butte's new appointment was effective May 26. He will be in charge of the London group. **Lewis E. Andrews** has been appointed contract manager of the newly created Central Division of **Loffland Brothers Company,** headquartering in Tulsa, and **Alva H. Stephenson** was appointed chief engineer, Southern Division, headquartering in New Iberia, La.

A. H. Crowell

A. H. Crowell has been promoted to the new position of employe relations coordinator for **Gulf Oil Corporation** in Houston. In his new assignment, Crowell will advise the domestic operating departments on employe relations matters. He will be responsible to **K. E. Rotegard,** manager of the New Services Department. **W. B. Billock,** in Pittsburgh, will continue to direct over-all policies concerning employe relations.

J. L. LeBlanc, formerly East Delta Area superintendent, **The California Company Division** of **California Oil Company,** has been appointed assistant division superintendent for the Delta-Gulf Coast Division. He replaces **E. W. Harter** who has transferred to the company's Bay Marchand Area, Leeville, La., as area superintendent. He replaces **Harry Dupre** who transferred to New Orleans as assistant chief engineer (Petroleum). **T. H. Jackson, Jr.,** has been appointed the new position of area superintendent for the new Venice, La., Area of the Delta-Gulf Coast Division. Other changes in the Venice Area include **W. H. Schell,** now production supervisor; **R. W. Donaldson** and **Leo Fisher,** now lead petroleum engineers, and **W. E. McClung** has been appointed area construction engineer. **Alan V. Martini** has been appointed division superintendent of Calco's Southeast Louisiana Division replacing **Larry W. Funkhouser** who is transferring to the **Standard Oil Company of Texas Division of California Oil Company.** He will headquarter in Sotex's Midland, Texas, office as division superintendent.

F. Cushing Smith, executive vice president and a director of **American Oil Company,** has joined the **Advisory Committee of the Transportation Center** at **Northwestern University,** Evanston, Ill.

John C. Quilty has been appointed to the new position of general manager of **Shell Oil Company's** personnel and industrial relations organization. Quilty had been manager of the Industrial relations Department.

James F. Doyle, Bureau of Land Management, area administrator, of Portland, Oregon, has been promoted to an assistant director of the Bureau. Doyle will work primarily on plans and legislation.

William R. Scott has accepted a vice presidency with **Photogravity Co., Inc.** He will be primarily concerned with administration of field operations and interpretation.

W. J. Harkey has been appointed by **Namco International, Inc.,** as its resident manager in Adelaide, South Australia. He will supervise a seismic exploration program which Namco is to conduct for Delhi Australian Petroleum Limited.

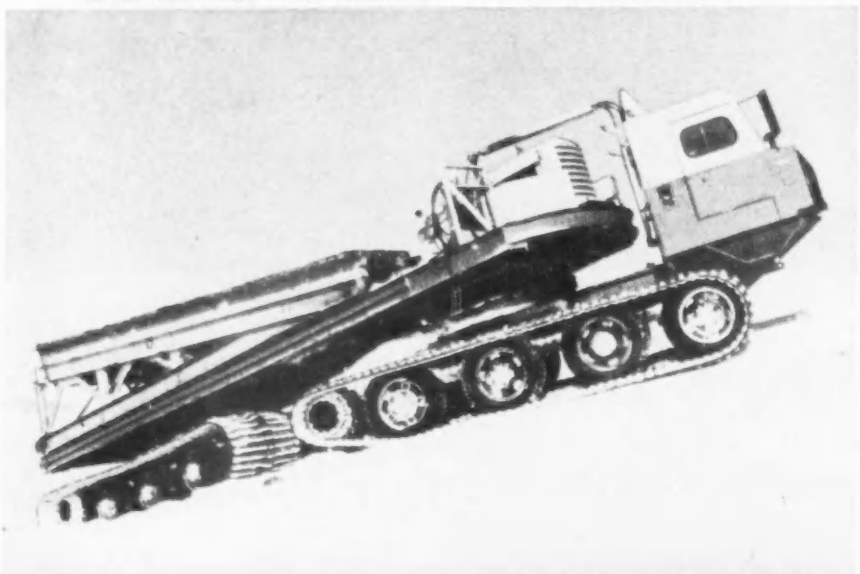
W. P. Carver, formerly division landman, Western Division, **Mobil Oil Company,** has joined **Great Basins Petroleum Company** as vice president and director.

Thomas M. Curtis has been appointed district superintendent for **Pan American Petroleum Corporation's** producing activities in its Farmington, N.M., District.

R. E. Old, Jr., has recently opened offices at Old Oaks Farm, R.F.D. 1, at Telephone, Texas, as a petroleum consultant. Old has been associated with the industry since 1937. He was general manager, Stekoll de Venezuela, S.C., in Caracas, Venezuela, from 1958 to 1961.

H. E. Christensen has been appointed assistant general manager, Domestic Producing Department of **Texaco Inc.,** and will be located in Houston.

CRUISING THE WORLD'S MOST RUGGED MILES



MODEL RN 200 — Giant 8 axle, 4 track, 2 engine TRANSPORTER, 20,000 lb. payload.

Nodwell ingenuity delivers exploration and construction equipment to any work site - at less cost per ton mile! "Go Everywhere Tracks" conquer every obstacle of terrain and weather to successfully keep the job "on schedule".

* VERSATILITY: Range of 7 models
* CAPACITY: One to Ten Tons
* MOBILITY: In muskeg, snow and rugged terrain. Ground bearing pressure 2 p.s.i., fully loaded.

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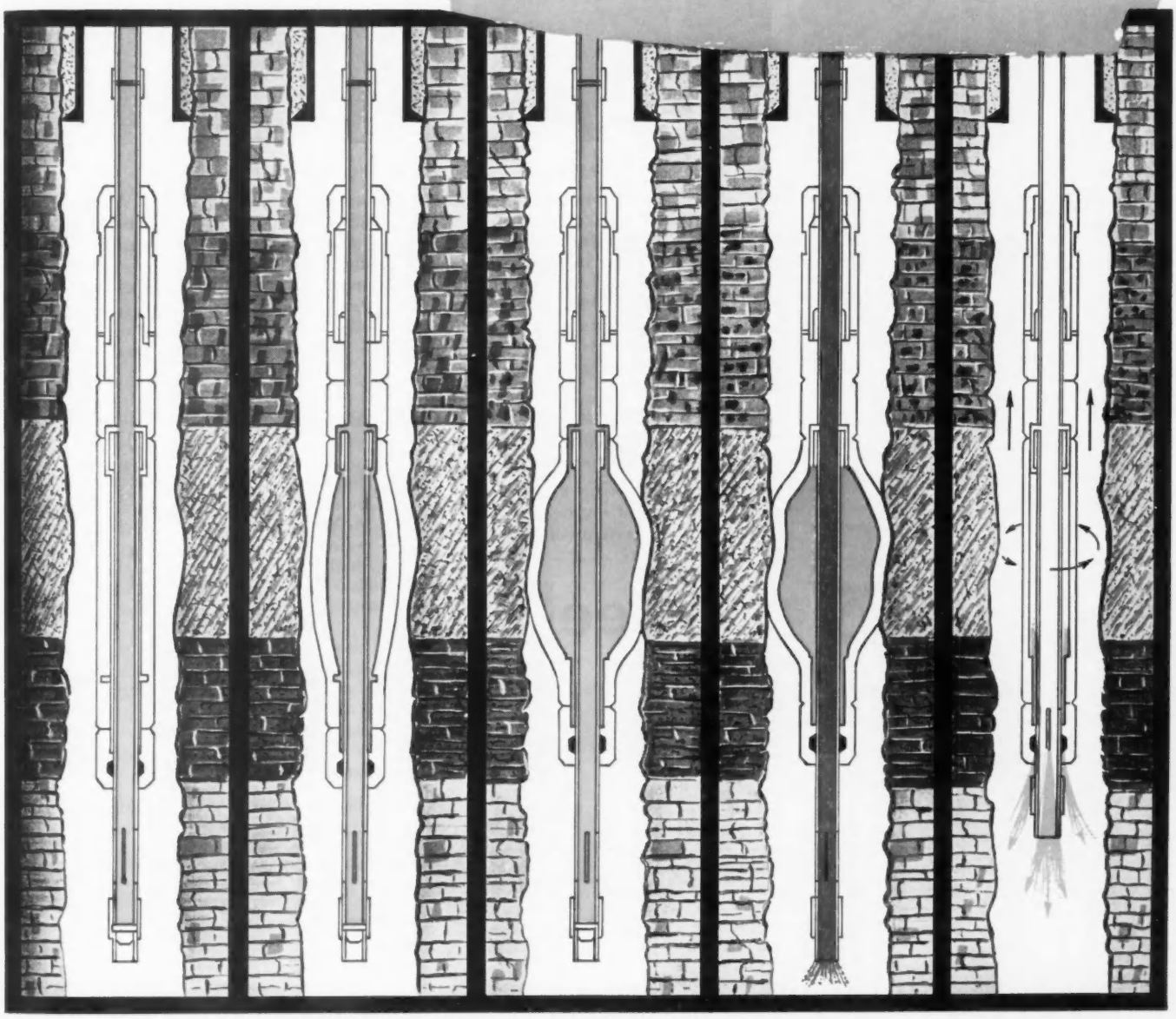
THE CARRINGTON COMPANY

HOW LYNES "PIP" PACKER SEALS IN OPEN HOLE OR CASING

The simple, positive operation of the Lynes inflatable "PIP" packer makes every driller a packing expert. Setting is merely a matter of running the tool into the hole on tubing or drill pipe to the exact depth desired and pressuring up on the pumps. The steel reinforced rubberized sealing element expands up to twice its run-in diameter to effectively seal in open hole or in casing. The sealing element is 53 inches long.



Here's How It Works

Make up "PIP" Packer on tubing string with knock-out or rupture disk in bottom. Run to desired setting depth.

Fill string with fluid. Pressure-up on fluid.

Packers for use in casing have "friction grip" elements with metallic particles imbedded in the rubber cover to produce high anchoring friction against the casing.

Check valves in ports open under pressure and sealing element inflates. Check valves hold pressure in sealing element when pressure in string is released.

Sealing element grips bore or casing wall and will hold against high differentials from above or below without weight on string.

To open below packer, knock out disk with sinker bar or increase pump pressure to rupture disk.

To release packer, rotate string to right, pull up 1½ feet. Fluid escapes from inflated sealing element along grooves on mandrel. Wait 15 minutes and pull out of hole.

Available in sizes 3½" through 5⅝" to seal in holes up to 11".

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SALES LOCATIONS

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For more data on advertised products, use Readers' Service Cards, last page.

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

J. C. KINLEY CO., Licensees

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Eads Engineering Services, Inc. ..... OR 2-8655
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GLENDIVE, MONTANA—C. A. White ..... EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co. 3-5396
KILGORE, TEXAS
Davis-Kemp Tool Co., Inc. 5541
LIBERAL, KANSAS—Rainbo Service ..... Main 4-3598
LINDSAY, OKLAHOMA
Rainbo Service Co. ..... PL 6-2530
MIDLAND, TEXAS
Luccous Service & Eqpt. Co. ..... MU 2-8311
NATCHEZ, MISSISSIPPI
Davis-Kemp Tool Co., Inc. 2-3021
NEW IBERIA, LOUISIANA
Klein-Deco Wire Line Service ..... EM 9-6632
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co. ..... ME 4-2131, ME 4-0105
STERLING, COLORADO
Cable Drilling, Temp. & Well Serv. Co. ..... LA 2-4761
VIDALIA, LOUISIANA
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Kline Wire Line Co. ..... OX 3-2731
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Eads Engineering Services, Inc. 766-0931
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Men in the industry

Crawford Addresses Oil Men at Annual Dinner

Dr. Paul B. Crawford, Texas Petroleum Research Committee, Texas A&M College, was the main speaker at the North Texas Section of AIME and the Production Committee of the North Texas Oil and Gas Association annual joint dinner meeting which met recently in conjunction with the thirty-first Annual Meeting of the North Texas Oil and Gas Association. Pictured above are (left to right) Richard Newton, chairman, North Texas Section of AIME; Dr. Crawford; Frank O. Hall, oil editor, *Wichita Falls Record News*, and Roland Gouldy, consultant, chairman of the Production Committee of the North Texas Oil and Gas Association. Gouldy presided at the dinner meeting.

Harry Wassall & Associates have moved their Eastern Hemisphere Division offices to Geneva, Switzerland.

Z. E. Stucky has been appointed manager of the Mid-Continent Region in the Exploration Division of **Cities Service Petroleum Company. M. J. Wells** will return to the Bartlesville, Okla., headquarters office as assistant chief geologist. **Wm. M. Schulz** will continue as region exploration geologist, and **Harry McMullen** of Bartlesville will be the new region development geologist and **G. N. Shell** will continue as region geophysicist. **Sam Franklin** of Midland, Texas, will be the new region landman.

John G. Yeager has been appointed manager of the Crude Oil Department of **Humble Oil & Refining Company's** Humble Division, succeeding **J. C. Posgate** who has been appointed manager of the Midland, Texas, Area of the company's Southwest Region.

Holland R. Hunter, an independent petroleum engineer from Houston, has been named chief engineer for the **Mayflo Oil Company.**

D. H. Barran, president of **Asiatic Petroleum Corporation** and **Shell Caribbean Petroleum Company,** New York, has been appointed to the board of **The "Shell" Transport and Trading Company Limited,** to succeed **F. J. Stephens** as a managing director of the **Royal Dutch/Shell Group** of Companies with effect from July 1.

Douglas Preble has joined the staff of **Byron M. Finch, Oil and Gas Consultant,** Charleston, W. Va., as a geologist.

Edde K. Hays of Chicago, has been elected a director of **Texas National Petroleum Co.** Re-elected officers are **Ralph A. Johnston,** chairman of the board; **W. Stewart Boyle,** president; **L. C. Oldham, Jr.,** vice president; **W. T. Withers,** vice president-production; **John W. Cooke, Jr.,** vice president-chief geologist; **George E. Zubrod, Jr.,** treasurer, and **Errol Anderson,** secretary.

COUPLINGS BY Wheeling

LINE PIPE COUPLINGS A. P. I.
⅛" to 16"—Seamless, Black or Galvanized
PLAIN TUBING COUPLINGS A. P. I.
1" to 4"—Seamless
EXTERNAL UPSET TUBING COUPLINGS A. P. I.
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All Sizes and Types
STEEL BUSHINGS AND PLUGS
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WHEELING MACHINE PRODUCTS CO.

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Right up to your doorstep

A NEW JOINT MARKETING PROGRAM WITH HUNT TOOL COMPANY BRINGS OUR EXCHANGE TOOLS AND EQUIPMENT WITHIN VALUABLE TIME SAVING REACH

The facilities of Hunt Tool Company have been obtained for wider distribution and faster exchange of our tools and equipment. Our customers will now profit by an expanded service previously not available, and we look forward to serving you even better under this accelerated program. Users of this door step exchange service will benefit in many ways, for example:

1 Shut down or waiting time is eliminated.
2 Customer's need for surplus inventories is eliminated.
3 Exchange material is guaranteed to give "Same-as-new" service.
4 Exchange is made at the same price as "renewing."
5 Fluid ends modified to conform to latest designs are also available.

Call Houston Slush Pump Company or Hunt Tool Company when you need fluid ends, pump liners, tongs, roller drive bushings and housings, elevators, rotary slips and inserts, casing slips, master drive bushings, kelly safety stop-cocks, rotary tables, swivels, swivel wash pipe, power pumps, plug and gate valves and other related items.

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HOUSTON SLUSH PUMP REPAIR CO.

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Specializing in building up and machining sand-washed liner cylinders, valve seat ports and rebuilding power ends

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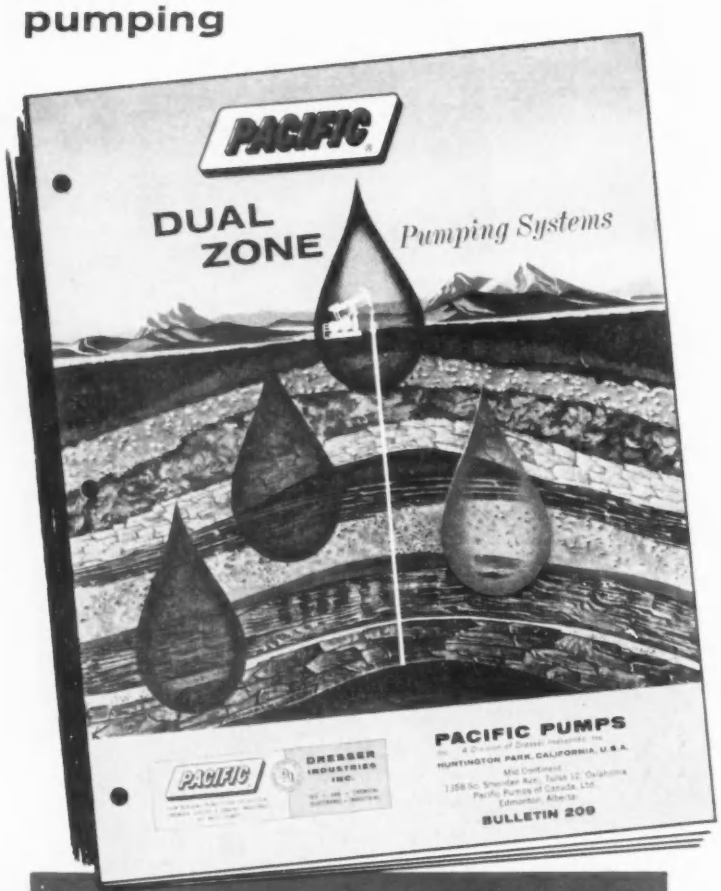
brings you *(the most)*
economy and efficiency
for your dual zone
pumping



Write for Bulletin 209

PACIFIC DUAL ZONE pumping systems provide maximum economy in producing dual completed wells where co-mingling of zone fluids is not permitted. Both zones are produced from the same well bore, using a single rod string and pumping unit.

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CENTRIFUGAL PUMPS FOR PETROLEUM, CHEMICAL, UTILITY & GENERAL INDUSTRIES
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Pacific Pumps of Canada, Ltd.,
Edmonton, Alberta

WHO'S MEETING WHERE

June 1– 2	Kentucky Oil & Gas Association Annual Meeting, Phoenix Hotel, Lexington, Ky.
1– 3	Interstate Oil Compact Commission, Midyear Meeting, Shamrock Hilton Hotel, Houston.
5– 6	Petroleum Electric Power Association Meeting, Mayo Hotel, Tulsa.
5– 9	SAE Summer Meeting, Chase-Park Plaza Hotels, St. Louis.
11–15	ASME, Summer Meeting, Statler-Hilton Hotel, Los Angeles.
11–16	API Division of Production, Midyear Committee Conference, St. Francis Hotel, San Francisco.
14–16	ASME Applied Mechanics Conference, Illinois Institute of Technology, Chicago.
21–24	American Association of Petroleum Landmen Convention, Shamrock Hilton Hotel, Houston.
July 6– 8	International Oil Scouts Association, Annual Meeting, The Roosevelt Hotel, New Orleans.
10– thru 18	Institute in Chemistry and Geology for High Ability Secondary Students, Colorado School of Mines, Golden, Colo.
26–28	API Division of Production, Eastern District Meeting, Greenbriar Hotel, White Sulphur Springs, W. Va.
Aug. 2– 5	Wyoming Geological Association Sixteenth Annual Field Conference, Casper, Wyo.
Sept. 13–15	Louisiana-Arkansas Division of Mid-Continent Oil & Gas Association Thirty-ninth Annual Membership Meeting, Roosevelt Hotel, New Orleans.
17–20	AIEE Annual Electrical Conference on the Petroleum Industry, Jung Hotel, New Orleans.
24–26	Empire State Petroleum Association Fall Meeting, Sagamore, Lake George, N.Y.
24–27	ASME, Petroleum Mechanical Engineering Conference, Hotel Muehlbach, Kansas City, Mo.
25–27	Texas Mid-Continent Oil & Gas Association Forty-second Annual Meeting, Texas Hotel, Fort Worth.
Oct. 3– 5	Dallas Geological Society hosts South-Western Federation of Geological Societies Fifth Annual Meeting, Karcher Auditorium, Southwestern Legal Center, Southern Methodist University, Dallas.
4– 6	AAODC Twenty-First Annual Meeting, Rice Hotel, Houston.
4– 6	ASME, Process Industries Conference, Shamrock-Hilton Hotel, Houston.
8–11	SPE of AIME Thirty-sixth Annual Fall Meeting, Memorial Auditorium, Dallas.
15–17	National Association of Oil Equipment Jobbers Eleventh Annual Convention and Trade Show, Mayflower Hotel, Washington, D.C.
18–20	Sixteenth Annual Convention of the Rocky Mountain Oil & Gas Association
18–21	AAPG Pacific Section Regional Meeting, Los Angeles.
23–26	The Metallurgical Society of AIME Fall Meeting, Pick Fort Shelby Hotel, Detroit.
29–31	Independent Petroleum Association of America, Annual Meeting, Shamrock-Hilton Hotel, Houston.

Nomad's Chapter monthly meeting: Los Angeles, second Wednesday, Biltmore Hotel, Wallace A. Sawdon, Secretary. Houston, second Monday, Kaphan's, Elbert T. Walker, Secretary. Dallas-Ft. Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

"Every dollar in our production budget is doing a man-size job . . . take these Unibolt Valves, for instance"

The UNIBOLT WING VALVE was designed originally as an "adjustable choke" for Christmas tree service. It is performing that job with distinction everywhere.

However, production men have found so many other uses for this wing valve that it is losing its original identity and is now regarded as an excellent multi-purpose valve!

Gas meter runs are one good example of this valve's versatility. It is equally popular on oil gathering manifolds, waterflood injection manifolds, heater-treaters, and a wide range of special valve applications. The one-inch opening in the UNIBOLT Valve will usually pass a far greater volume of gas than can be produced. Unlike conventional single purpose gate and plug valves, the UNIBOLT Valve offers a number of advantages: Conversion to positive choke or Pressurematic Valve, completely salvageable, easily renewable parts, and selective trims.

Make every dollar in your production equipment budget do a man-size job, too! UNIBOLT Valves, Fittings, and Couplings are made for you with that in mind.

UNIBOLT

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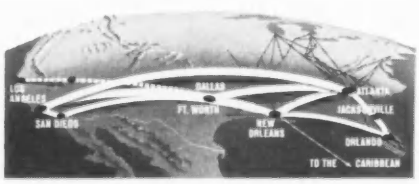
Eff. June 11

DELTA

announces a New Southern Transcontinental Jet Route linking California with the Southeast

Now 6 Jet flights daily between Los Angeles and Atlanta! Non-stop service in slightly more than 4 hours . . . other jet service links Los Angeles and Atlanta by way of Dallas / Ft. Worth and New Orleans. Plus new thruplane DC-7 service linking San Diego with Jacksonville and Orlando, via Dallas / Ft. Worth and New Orleans. Effective July 1, Delta service to Las Vegas.



Delta's new routes to the West Coast

DELTA

A New Southern Transcontinental Route

Associations

International Guests Visit Houston NOMADS

At a recent meeting of the Houston Chapter of NOMADS, the following international guests were in attendance (sitting, left to right): A. R. Uliana, Y. P. F., Buenos Aires, Argentina; W. C. Robinson, Robinson Oilfield Specialties, Calgary, Alta.; Kraus Earheart, Texaco Inc., Houston, speaker for the evening, and R. H. Buccella, Y. P. F. Buenos Aires, Argentina. (Standing, left to right) D. S. Hare, Pauley Pan American, Mexico City; Roy Bobo, consultant, Comodoro Rividavia, Argentina; Gilbert Galtie, CEP (A) Algiers, Algeria; C. W. Black and S. P. King, Tennessee Argentina; Terra del Fuego, and H. Beklik, Tehran Supply, Tehran, Iran.

TIPRO Names J. F. West President And W. Stewart Boyle Secretary

J. F. West of Stamford was elected the thirteenth president of the Texas Independent Producers and Royalty Owners Association at that group's fifteenth annual meeting in Midland, Texas. West succeeds John Hurt of Laredo who becomes vice chairman of the executive committee.

W. Stewart Boyle, president of the Texas National Petroleum Company, Houston, was named secretary, succeeding West. Vance Foster, Dallas, was re-elected treasurer; W. E. Turner, Austin, was re-elected executive vice president, and John Davenport, Austin, was re-elected general counsel.

Regional vice presidents and executive committeemen also were elected. In South and Southeast Texas these officers and committeemen were named:

District 1—David T. Roche, Austin, and J. E. Kendal, San Antonio, vice presidents; Thornton C. Huddle and Gordon W. Johnson, both of San Antonio, and Walter R. Koch, Austin, executive committeemen.

District 2—W. R. Dean, Victoria, vice president, and Ignatius P. O'Neil, Beeville, executive committeemen.

District 3—Wilbur Ginther, Houston, vice president; Michel T. Halbouty, J. U. Teague, J. C. Goldston, C. W. Alcorn, H. J. Porter and A. P. King, Jr., all of Houston, and C. A. Miles, Jr., Liberty, executive committeemen.

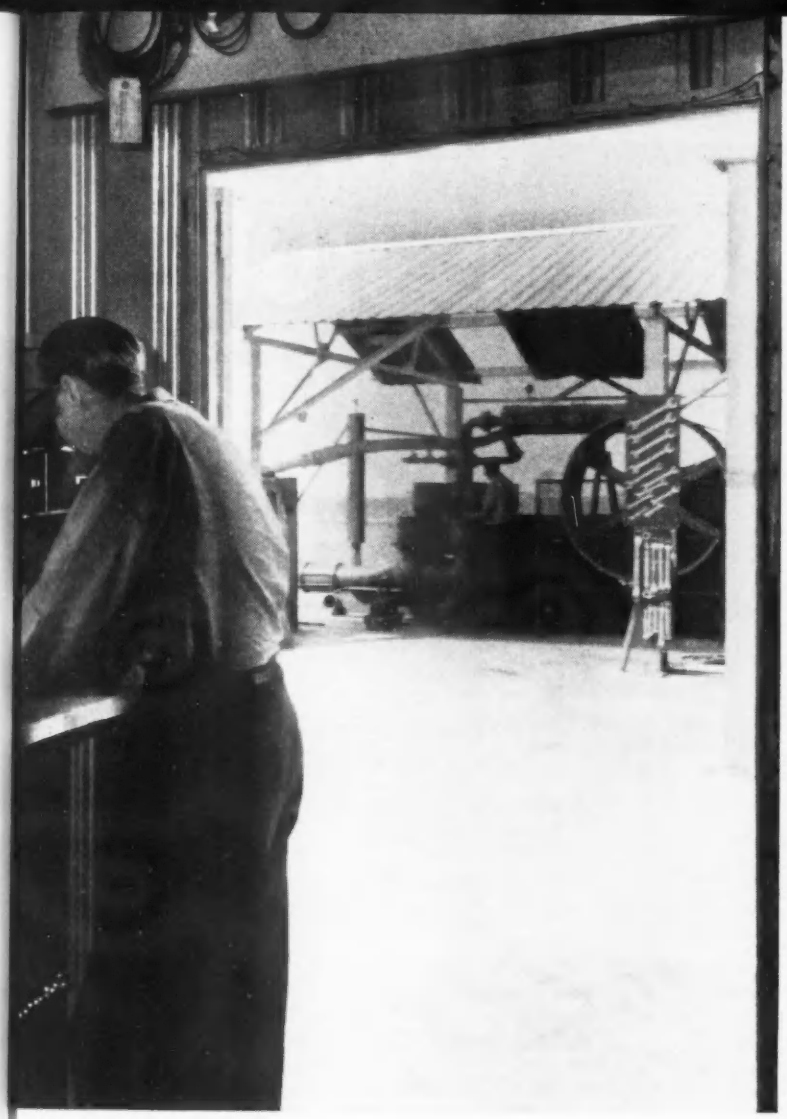
District 3A—Bryan D. Beck, Jr., Beaumont, vice president, and C. Tyrrell Garth, Jr., and Walter J. Crawford, both of Beaumont, executive committeemen.

District 4—W. E. Carl, Corpus Christi, and H. B. Harkins, Alice, vice presidents; W. V. Byrd, John Hawn and Guy I. Warren, all of Corpus Christi; C. E. Thompson, McAllen, and Neal D. Terrary, Alice, executive committeemen.

Johnny M. Mitchell, president of the Jade Oil Company, a partner in Christie, Mitchell and Mitchell and a long-time leader in TIPRO affairs, was presented the chief roughneck award which the Lone Star Steel Company has been making to an outstanding member of the association since 1955. The award was presented to Mitchell by Houston oil man, R. E. (Bob) Smith.

Millard E. Stone Named to API's Committee on Public Affairs

Millard E. Stone, vice president in charge of employe and community relations for Sinclair Oil Corporation, has been named to the Committee on Public Affairs of the American Petroleum Institute. Stone succeeds Joseph P. Wash, general counsel for Sinclair, as a member of the committee.



No hole but pay every day

This installation works overtime just about every day, and the "pay" it produces ends up in your pocket. It's an "Oilwell" test center where we simulate actual drilling and waterflood pumping conditions to assure the dependability of "Oilwell" Pumps and Parts. Conditions can be varied from light loads to excessive overloads, and we can duplicate the roughest service you'll ever encounter. Complete instrumentation measures and records wear and performance of slush pump and plunger pump fluid end parts; we test everything about a pump, even the V-belts, gaskets, packing and oilers. From the data we collect come new designs, improved products and, ultimately, the kind of reliable performance that lowers *your* operating costs. Extensive testing is only one of many "Oilwell" services which include research, application, installation, and maintenance.

One-stop shopping

Suppose your want list read like this: one pumping unit—one gas engine—one polished rod—one 4″ plug valve—two safety hats—one 24″ pipe wrench—and a 10 lb. box of rags. Where do you suppose you could get it all—all at once? At your nearest "Oilwell" store, of course. We're in business to give you quality products when and where you want them. Whatever your need, you'll find that when you get it from an "Oilwell" store, it will be of the best quality and priced right. And you won't have to go far because "Oilwell" stores are located for the convenience of our customers. That's why we say—"Wherever there's oil—there's 'Oilwell".

USS

Oil Well Supply
Division of
United States Steel

Executive and Export Offices: Dallas, Texas

MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

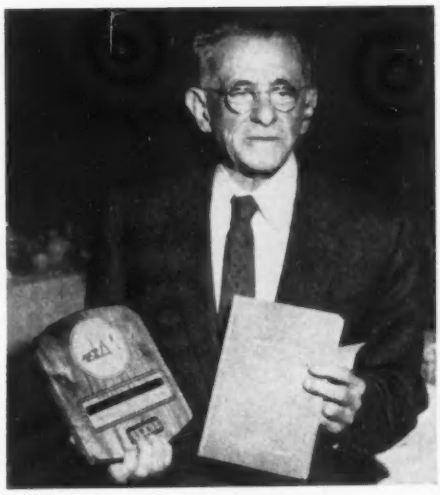
MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

Write for our new catalog or see it in the Composite (24th Edition). All products sold thru supply companies.

JOHN N. MARTIN
Manufacturer
9 W. BRADY STREET • TULSA, OKLAHOMA

Associations



Honored With Namesake Award

J. C. Slonneger was named first recipient of a new award that hereafter will be named in his honor "The J. C. Slonneger Award". He was honored for his designs and inventions at the recent West Texas Oil Lifting Short Course at Texas Technological College in Lubbock, Texas.

Philadelphia Geologists Form New Geological Society

Kalman N. Isaacs of Aero Service Corporation, has been elected president of the recently formed Philadelphia Geological Society. Dr. Horace Richards of the Academy of Natural Sciences was elected secretary-treasurer.

The executive committee consists of Ronald R. Hartman of Aero Service Corporation, who first envisioned the Society and much of the initial organizational work; Dr. Edward Watson of Bryn Mawr College; Dr. Robert Fulton of du Pont de Nemours Company; Dr. Carlyle Gray of the Pennsylvania Geological Survey, and Dr. Jorma Kalliokoski of Princeton University.

J. R. Lavens Elected Tri-State Oil Association President

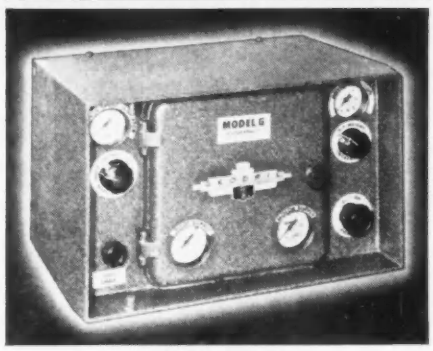
John R. Lavens, Jr., president of Oilfield Research, Inc., Evansville, Ind., has been elected president of the Independent Oil Producers and Land Owners Association, Tri-State, Inc., Evansville, at the group's recent meeting.

John M. Kelly, assistant Secretary of the Interior, along with Indiana Congressman Winfield K. Denton, Illinois Congressman George Shipley and Lawrence Alley, secretary of Interstate Oil Compact Commission, spoke to the gathering Tri-State oil producers.

Other officers elected were Victor R. Gallagher, president of Victor Drilling Company, Evansville, treasurer; J. D. Turner, independent operator, Evansville, secretary, and Elmer L. Hoehn, Jeffersonville, Ind., executive secretary.

Elected to the executive committee were James Buthod, attorney, Evansville; T. M. Egan, independent producer,

MORE HOLE PER DOLLAR



THE GEODRIL MODEL G COMPACT AUTOMATIC DRILLING CONTROL GIVES YOU:

- Longer Bit Life
- Better Coring and Reaming
- Straighter Hole
- Reduction in Twist-Offs

SAVES YOU:

- Costly Downtime
- Equipment Wear
- Time to Contract Depth
- Dollars per Day

Considerable savings to the contractor in both time and money can be obtained through any of these.

Today's highly competitive drilling situation makes it essential that the optimum drilling rate be maintained from grass roots to total depth. The Model G Geodril Automatic Driller provides this assurance while maintaining safe, reliable control of the brake at all times.

If you want more hole per dollar, contact your nearby Geograph Oil Field Services Office. Ask for Catalog 223.

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OIL FIELD SERVICES
P. O. Box 1276
Oklahoma City 1, Okla.

red bag or blue bag?

(One of them can help you get the mud viscosity you need)

In a low-solids mud area like West Texas or the Rockies, you need a CMC that will build mud viscosity as well as reduce fluid loss.

That's the red bag – Du Pont's High Viscosity "Qualex". No other CMC can build mud viscosity as well.

In a high-solids mud area like the Gulf Coast, you need a CMC that will not boost the viscosity of your mud, while still maintaining fluid loss control.

That's the blue bag – Du Pont's Low Viscosity "Qualex". When you use Du Pont Low Viscosity "Qualex" for fluid loss control, you save the cost of other additives since you don't have to use thinners or water back the mud to compensate for viscosity caused by the CMC.

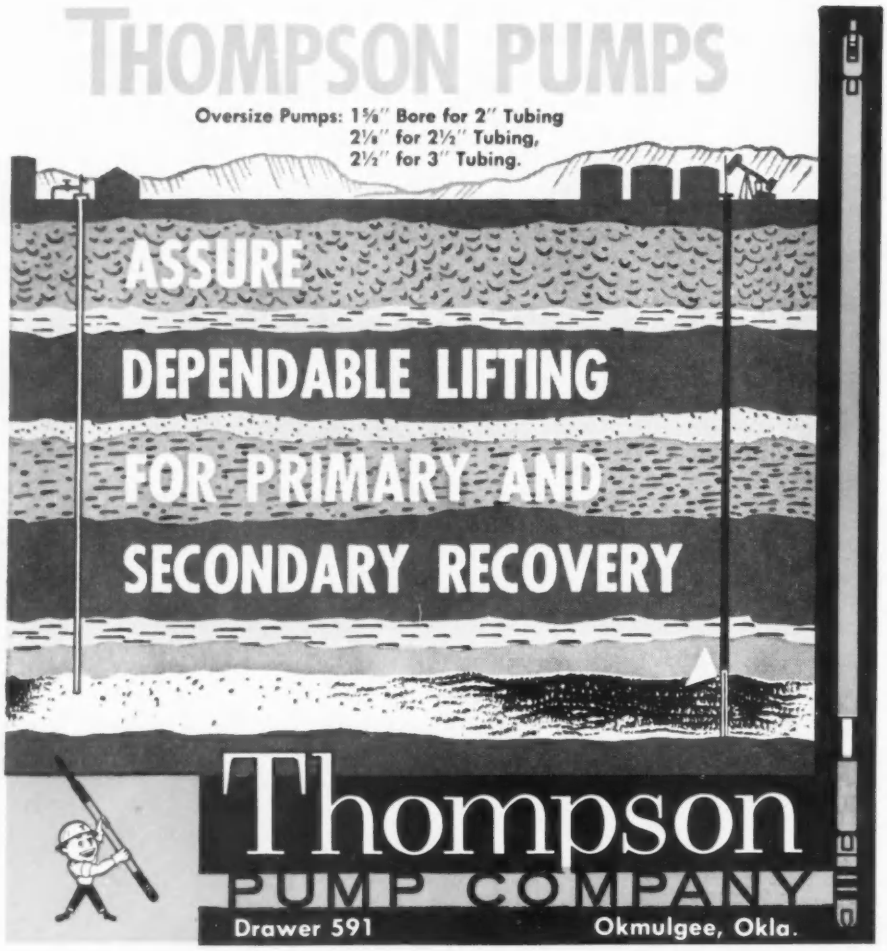
Your mud dealer can supply you now. Which will it be – red bag or blue?

(Your dealer also has Du Pont "DM" grade CMC, in both high and low viscosities.)

CMC

DU PONT

Better Things for Better Living . . . *through Chemistry*



oilfield
transporting
equipment
OILFIELD TRUCK AND FLOAT
Thornycroft Sandmaster 252" wheel base Oilfield Truck. Hands-England full Oilfield Body. 60,000 lb. winch, heavy duty gin poles, winch operated gin pole risers and folding SAE king pin.
Hands-England 75,000 lb. capacity, tandem axle Oilfield Float 30'0" long and 9'6" wide, folding support legs and inverted 36" fifth wheel.
Truck and Float on Michelin 18.00 x 25. Sahara "X" sand tires.
OILFIELD FLOAT
Hands-England 75,000 lb. capacity tandem axle Oilfield Float 30'0" long and 8'6" wide, folding support legs and inverted 36" fifth wheel.
Float on 11.00 x 20—14-ply tires.
OILFIELD TRUCK AND FLOAT
Scammel Constructor 261" wheel base Oilfield Truck.
Hands-England 75,000 lb. capacity tandem axle Oilfield Float 30'0" long and 9'6" wide folding support legs and inverted 36" fifth wheel.
Truck and Float on 14.00 x 20—18-ply tires.
OILFIELD FLOAT
Hands-England 25,000 lb. capacity single axle Oilfield Float 24'0" long and 8'0" wide, folding support legs and SAE king pin 11.00 x 20—12-ply tires. Steel stake sides.
SUPPLIED BY
HANDS-ENGLAND OILFIELD EQUIPMENT LTD.
Works Road, Letchworth, Herts., England
Telephone: Letchworth 600 Telegrams: Oil, Letchworth Cables: Oil, Letchworth, England

Associations

Evansville; Frank Zogg, Zogg Oil Company, Owensboro, Ky.; George A. Hoffman, independent producer, Henderson, Ky.; W. G. Harris, Farrar Drilling Company, Mt. Vernon, Ill., and Ira Van Tuyl, VT Drilling Company, Evansville.

Directors elected were Charles Rafferty, T. W. George, Mt. Carmel, Ill.; Walter Keahey, Victor Drilling Company, Evansville; R. W. Kuzmich, RK Petroleum Corporation, Mt. Carmel; Stanley Lambert, independent producer, Owensboro, and Guy McGaughey, Jr., attorney, Mt. Carmel.

Landmen's Association Name George R. Bixler President

George R. Bixler, B. B. M. Drilling Company, Houston, has been named President of American Association of Petroleum Landmen. Bixler, who has been named by the nation's petroleum landmen as their head for the coming year, will take office in June following the organization's seventh Annual Meeting in Houston June 21-24. He succeeds Ralph L. Cormany, Oxnard, Calif.

G. R. Bixler

Bixler will be aided in the assignment by Haden J. Upchurch, Texas Eastern Transmission Corporation, Houston; James A. Walker, Kern County Land Company, San Francisco; Robert Gadbois, Shell Oil Company, Calgary; vice presidents, and Gerald Gotschall, U.S. Oil of Louisiana, New Orleans, treasurer.

M. L. Hill Takes Over As AAPG President

Mason L. Hill, Los Angeles, manager of exploration for Richfield Oil, is the forty-fifth president of the American Association of Petroleum Geologists. Hill took over as president of AAPG at the conclusion of the association's annual convention which was held recently in Denver. Hill succeeds Ben H. Parker, Frontier Refining, Denver, who now joins the executive committee as past president.

J. Ben Carsey, Humble Oil & Refining, Houston, is the new vice president; George V. Cohee, U.S. Geological Survey, Washington, D.C., is secretary-treasurer, and Grover E. Murray, Louisiana State University, Baton Rouge, is editor. Both the latter officers were re-elected to their respective positions.

New officers of the Society of Economic Paleontologists and Mineralogists which held its annual convention concurrently with that of AAPG, as is customary, assumed command of their organization. Laurence L. Sloss, Northwestern University, Chicago, heads SEPM; Kenneth E. Lohman, U.S. Geological Survey, Washington, D.C., is new vice president, and Lloyd C. Pray, Ohio Oil, Denver, becomes secretary-treasurer. Sloss succeeds William M. Furnish, Jr., as head of this organization.

GARDNER-DENVER MAKES THE NEWS

Important changes are now in progress in the drilling industry. As holes have become deeper and costs per foot drilled have continued to rise, operators have become aware of the advantage in using equipment that has been engineered to work together as a balanced team for maximum speed and efficiency. It is only natural that the ultimate in operating economy and efficiency can be achieved when there is a single source for engineering, fabrication and service of this equipment.

Recognizing this need, Gardner-Denver, one of the largest manufacturers of mud pumps, air compressors and air drilling equipment, has now completed a full line of oil drilling equipment for every depth well from 4,000 to 30,000 feet.

Unique in the drilling equipment industry, Gardner-Denver equipment designs were not limited by existing equipment and tooling. Without fear of obsoleting existing stocks, Gardner-Denver engineers directed their efforts to producing the most advanced equipment that could be built . . . to developing new concepts of torque/speed combinations that would give more usable horsepower and lower maintenance costs.

Typical of these new Gardner-Denver drawworks designs is the Gardner-Denver 1100, a 1,100 horsepower drilling unit for depths to 15,000 feet. Similar in basic design to the larger Gardner-Denver 2100 and 1500 drawworks, the Gardner-Denver 1100 is built around a single package, side skidded drawworks. All controls, transmission, auxiliary brake and drawworks are mounted on the main skid. This integral arrangement offers many time saving advantages, including faster rig-up and moving, positive alignment of transmission and permanently mounted control panel.

Rugged Drawworks Construction

Heavy steel plate, doubled at bearing centers for extra rigidity, is used for the drawworks housing. A continuous ring of steel plate is welded around shaft openings to eliminate distortion of the side plates. This feature greatly increases bearing life. Engineering of sprockets, ratios and bearings has been unitized to produce a balanced torque/speed combination that lengthens chain and bearing life.

Short Shaft Transmission

Hi and lo main drum clutches give the driller a selection of eight hoisting speeds and a reverse. The transmission is ratioed in four speed increases. Equalization of the speed increases has produced a smooth progression over the entire range.

Short shafts and bearing centers are an outstanding point of the transmission design.

Tension Bar Equalized Brakes

Extra braking power through 330 degree wrap brakes make the Gardner-Denver 1100 an easy-to-handle rig that will stop the heaviest load with precision. A tension bar equalizes both brakes for a balanced pressure on the rims. A centralized lubrication panel supplies lubricant to all brake linkage.

The driller can control the water level within the hydromatic brake without leaving his station. An indicator gauge and control valve are mounted on the console.

Matching compounds for two and three engines in both stair-step and in-line arrangements are available for the Gardner-Denver 1100.

A brochure covering each drawworks and companion equipment is available on the full Gardner-Denver line. Stop in at your nearest supply store or write direct for your copy.

Gardner-Denver has great faith in the future of the petroleum industry and the men who have made it one of our nation's most important assets. This confidence is expressed by the recent expansion of its Petroleum Division to include the manufacture of a complete line of drilling equipment: drawworks, rotary tables, swivels and blocks. To assure you of the finest equipment, Gardner-Denver has invested in new tools, plants and obtained the services of the industry's outstanding engineers. All of us at Gardner-Denver are looking forward to serving you through our expanded Petroleum Equipment Division.

(Adv.)

"UPS" and "DOWNS" KILL PROFITS!

Prevent DOWNTIME & BURNED UP ENGINES.

Murphy engine panels instantly ground magneto* when lube oil pressure or cooling system fails for any reason.

MODEL W-275 $17.75

MURPHY

Exclusive semi-automatic lockout takes grounded contacts out of circuit for starting. Automatically are placed back in circuit by lube oil pressure after starting. Temp. range 100°-220° F. Oil pressure range 0-75 psi.

MODEL W-275-2—$31.50

Same as above but has new 202 snap switch to ground both magnetos when switch-gauges operate. Uses power of either or both magnetos to trip. For 4 magneto engines, order W-275 and 404 mag. snap switch.

•

Easy to install. Field adjustable while engine running. Patented micrometer contact adjustments allow for extremes of operating conditions or altitude. Rugged.

*See your engine dealer for complete line of switch-gauges for multiple magneto, battery ignition or diesel engines. Also time, temperature, pressure, level switches, engine & motor controllers, panels.

FRANK W. MURPHY MANUFACTURER, INC.
P.O. BOX 4010
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TULSA, OKLAHOMA
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MURPHY SAFETY SWITCH OF CALIFORNIA
11812 Davenport Road • Los Alamitos, Calif.

Suppliers' notes

G. H. Moore

Doyle Waller

George H. Moore has been promoted from assistant vice president, Marketing, to vice president, Marketing of **Magnet Cove Barium Corporation.** At the same time, **Doyle Waller** was transferred and promoted from supervisor, Engineering Training Laboratory, Technical, Department, to Coordinator of Field Training-Sales and Engineering, Drilling Mud Department.

T. G. Evenson, sales engineer at Newcastle, Wyo., has been promoted by **Schlumberger Well Surveying Corporation** to manager of that location, while **W. M. Baker,** field engineer general in Glendive, Mont., was transferred to Billings as sales engineer. Also, **F. W. Beazley,** location manager in Pratt, Kan., has been transferred to the Kansas Division to serve as senior sales engineer. **L. F. Holdman,** field engineer general, Mt. Vernon, Ill., has been named sales engineer there. **L. H. Reynolds** has moved to the Louisiana Gulf Coast in Lafayette as senior sales engineer, and **G. M. Lehnertz,** senior sales engineer, moved from the North Central Division to Tyler, Texas.

L. K. Greer, salesman at Borger, Texas, for **Jones & Laughlin Supply Division,** has moved to San Antonio, and **F. P. Crahan,** salesman at Beaumont, Texas, has transferred to Cameron, La.

Paul Bartley has been named sales vice president of **Black, Sivals & Bryson, Inc.,** in a consolidation of the sales organizations of BS&B's Oilfield Equipment and Controls Divisions. Seven regional manager appointments have been announced: **Floyd C. Myers,** a vice president, Gulf Coast Region, Houston; **Lee Kelton,** Southwest Region, Dallas; **Ralph Stevens,** Mid-Continent Region, Oklahoma City; **L. E. Jones,** Rocky Mountain Region, Casper, Wyo.; **Austin Lyon,** North-East Region, New York City; **James Lee,** North-Central Region, Carmi, Ill., and **William E. Lacy,** Western Region, Los Angeles. At the central sales level executive staff appointments include the naming of **James E. Byers** as manager of Product Sales, Oilfield Equipment, and **Edward W. Reif** as manager of Product Sales, Controls & Specialty Products.

E. Frank Sanford, Jr., has been named Texas Gulf Coast Area representative for the **Kilby Steel Company** of Anniston, Ala. Sanford makes his headquarters in Houston.

Bolling A. Abercrombie has been promoted to manager, Product Planning, for **Axelson-Garrett Division of U. S. Industries, Inc.** Abercrombie will office at the Division's Longview, Texas, plant and will report directly to **Taylor Milton,** president of Axelson-Garrett.

John F. Adams has been appointed merchandising supervisor of **The National Supply Company of Venezuela, C.A.** Adams will headquarter in Caracas.

A. B. Colt has been named store manager for **Jones & Laughlin Supply Division** at Carmi, Ill.

John A. Daugherty has joined **Lucey Products Corporation** as vice president with offices in the Tennessee Building, Houston. Daugherty's activities will be directed toward development of the company's Gulf Coast program in the production and drilling branches of the industry.

Robert Boyd has been appointed executive vice president and general manager of **Guiberson Corporation.** Boyd succeeds **Alex Smith** who resigned from the same position. Guiberson officers now are: **J. B. O'Connor,** chairman of the board; **Gordon G. Guiberson,** president; **Boyd; R. E. Reimer,** vice president; **A. J. Wallis,** secretary; **C. H. Ballard,** treasurer; **T. V. Terry,** assistant secretary and assistant treasurer, and **J. D. Myson,** assistant secretary and assistant treasurer.

Robert Boyd

George T. Mays has been appointed sales representative for the **Mission Manufacturing Company's** oil field products in New Orleans and the surrounding area.

Robert C. Dunlop, Jr., has been elected a vice president of **Texas Instructments Incorporated,** following the resignation of **Fred J. Agnich.** Dunlop has become operating head of the company's geosciences activities and will continue to serve as president of **Geophysical Service Inc.,** TI's wholly owned exploration subsidiary.

Harold Wolpman has been promoted to senior vice president of **Grove Valve and Regulator Company.** Wolpman will be in charge of plant engineering, plant structures and new plant locations. At the same time, **Walter L. Connolly** was appointed vice president, Manufacturing, for Grove. Connolly formerly was director general of **Grove France,** Paris subsidiary of the firm.

William H. Wheeler, formerly manager of sales, **Holyoke Division** of **Worthington Corporation,** has been named general sales manager of the company's recently enlarged Construction Equipment Division at Holyoke, Mass.

High speed cyclic tension test— With its Fatigue Resistant FR* process, Link-Belt increases roller chain's endurance limit by compressing the metal around pitch holes . . . the critical sidebar areas most vulnerable to fatigue failure. On the test equipment above, Link-Belt has verified the superior fatigue resistance imparted by the FR process. The machine produces up to 65 tons of high speed cyclic tension . . . duplicates toughest conditions of rig operation.

*U.S. Patent No. 2,517,497

Shown here are just a few of the many *manufacturing extras* that contribute to the greater strength and endurance of Link-Belt FR (Fatigue Resistant) roller chain. Combined, these features assure you of precision chain that can withstand the smashing impacts and tortuous stresses met in day-to-day drilling.

Other advantages of Link-Belt FR roller chain include: SHOT-PEENED ROLLERS—specially cold-worked for extra life; SHEPHERD'S CROOK COTTERS—designed to remain in place despite severe vibration; SPECIAL BOXING—provides positive protection against dirt and moisture.

For engineering assistance in applying FR roller chain, write Link-Belt Company, Indianapolis 6, Indiana. And ask any leading supply store for Catalog 2980 . . . it contains full information on roller chain and other Link-Belt oil field equipment.

LINK-BELT

ROLLER CHAINS AND SPROCKETS

LINK-BELT COMPANY: Indianapolis 6, Houston 1, Dallas 26, Odessa, Tex., New Orleans 16, Shreveport, La., Los Angeles 22 (Montebello), Scarboro (Toronto 13); Export Office, New York 7. Distributors in All Fields. 15,679

Suppliers' notes

Zack Griffin has been appointed Permian Basin Area manager for **Johnston Testers, Inc.** Griffin will headquarter in Odessa, Texas, where he will have charge of Johnston operations in West Texas and Eastern New Mexico.

John Knodle has joined the Engineering Department of **C-B/Southern, a Division of The Cooper-Bessemer Corporation.**

W. D. Bryson has been elected a vice president of **Solar Aircraft Company,** a subsidiary of **International Harvester Company.** Bryson will have responsibility for coordination of Solar's engineering and production activities in a staff capacity reporting to **Herbert Kunzel,** president.

Leonard H. Busby has been named assistant to the general manager, **Oil Tool Division,** of the **Chicago Pneumatic Tool Company.** Other appointments include **Vernon Ash** elevated to Gulf Coast Division manager, with offices in Houston; assisting Ash is **Glenn A. Bilbo,** named special representative for that division; **Robert (Rudy) Rendall** was named district manager of CP's West Texas Division; **Thomas Tefertiller** has been promoted to assistant district manager, Oklahoma City; **Joe Curtis** was named special representative with headquarters in New Orleans; **Tim Allen** has been appointed sales agent of the South Louisiana Oil Tool Division. In Canada, **Donald Anderson** was elevated to district manager for the South Edmonton Area, and **Vernon Linn,** named as a special representative in Alberta, will work out of Calgary.

George Meyer has been appointed vice president-Manufacturing of **Parker Seal Company, a Division of Parker-Hannifin Coporation.** At the same time, Meyer announced that **Joe Nenzell** will continue as manager of Western Manufacturing, and **Earl Hobein** will continue as manager of Eastern Manufacturing.

George Meyer

Tom H. Frazer has been named sales promotion manager of **Continental-Emsco Company.** Frazer, former manager of the Production Equipment Department, began with the company in 1934 as a trainee in a company branch store. Other Continental-Emsco appointments include **C. L. Vickers** named vice president in charge of Finance, su ceeding **D. M. Bailey** who accepted the position of executive vice president with Southern Union Gas Co.; **Will D. Crowell** has been promoted to treasurer and credit manager; **Herbert P. Dawkins,** assistant treasurer and assistant credit manager, and **John F. Wagenhauser,** general counsel.

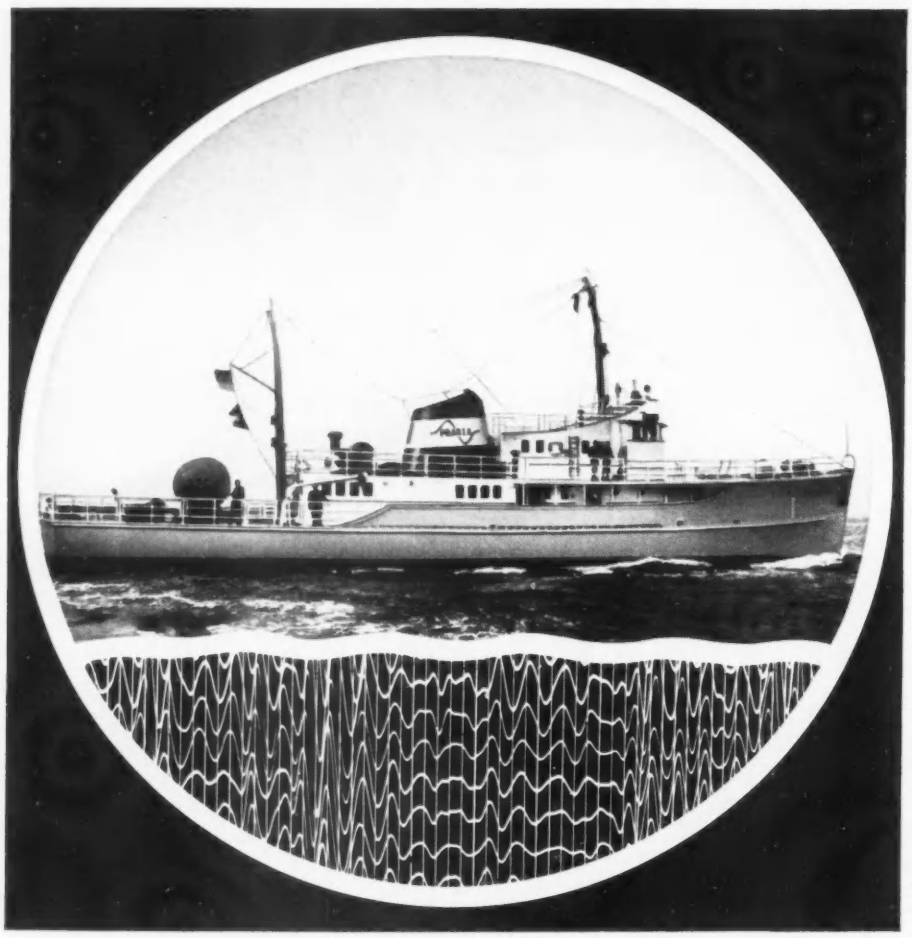
Homer Hill, former office sales coordinator, **W. C. Norris Division, Dover Corporation,** has been appointed manager of wellhead sales. He will be responsible for the sale and development of the company's wellhead equipment. **Orville L. Scott** has been named sales coordinator. Scott will coordinate field and office sales activities. Both men will headquarter in the Tulsa general office.

Carl D. Ward has been appointed division manager of **Information Systems, Inc.'s** Computer Division.

John Lubke has been appointed production superintendent at Odessa, Texas, by **Pipe Inspectors Division** of **Plastic Applicators, Inc.,** Houston. Lubke joined Pipe Inspectors in 1960 when Plastic Applicators purchased Trip Check, Inc., in which Lubke was a partner.

Leroy (Lee) Bidwell, Jr., has joined **Southwest Industries, Inc.,** of Houston, as manager and senior sales engineer of the firm's New Orleans branch office. Bidwell will coordinate sales and service of the firm's complete line of precision engineered equipment for the petroleum and chemical industries throughout New Orleans and the Louisiana Gulf Coast areas.

Harmon Cutler has been promoted to the position of plant manager by **Cal-Metal Pipe Corporation of Louisiana.** Cutler was superintendent of the Cal-Metal plant before becoming plant manager.



OFFSHORE GEOPHYSICAL MEASUREMENTS

BY

M. S. PROSPEKTA

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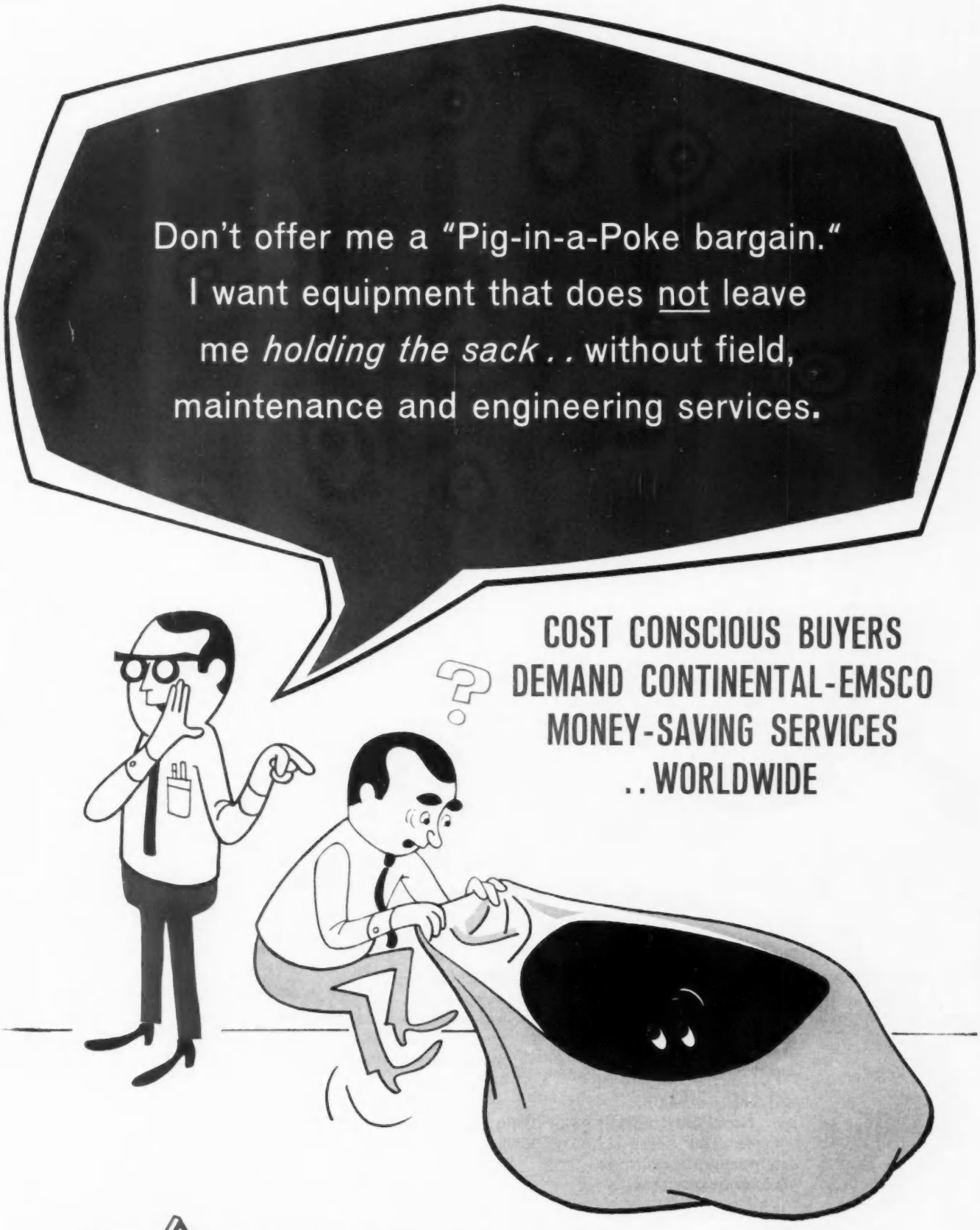
Don't offer me a "Pig-in-a-Poke bargain."
I want equipment that does not leave
me *holding the sack . .* without field,
maintenance and engineering services.
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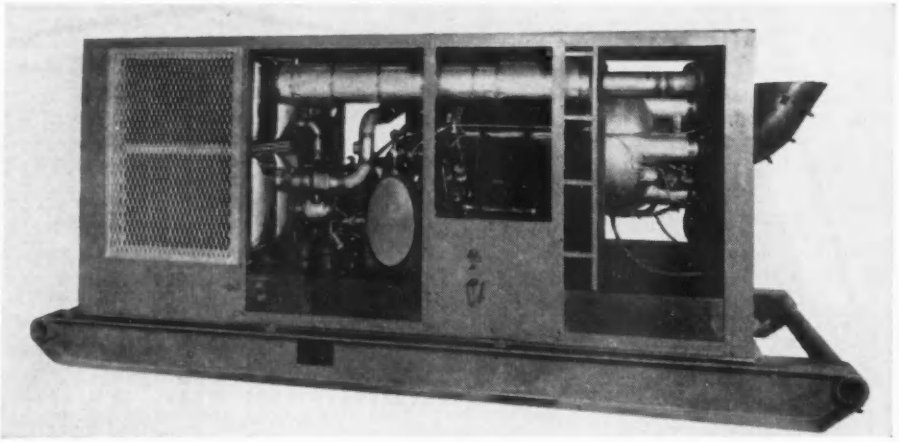
Continental-Emsco Company C. A., Caracas, Venezuela • Plants: Houston and Garland, Texas; St. Albans, Herts, England • *Representatives in All Principal Oil Fields of the World*

Suppliers' notes

P. E. Tobin has been made vice president-wholesale operations of the **White Truck Division of The White Motor Company.**

R. B. Park has been appointed manager-Industrial Rubber and Mechanical Packings, for **Raybestos-Manhattan, Inc.** Park has been assistant sales manager of these sales activities since 1959. At the same time, is was announced that **R. B. Hazard,** previously vice president and sales manager-Industrial Rubber and Mechanical Packings, has been appointed vice president-Sales, for these Sales Divisions of Raybestos-Manhattan. Hazard was elected a director in October.



Mission Manufacturing Company recently demonstrated its new Packaged Round Power units that are equipped with fully automatic controls which properly sequences starter operation, fuel control and ignition, thus providing a stable automatic starting cycle requiring only a single starter switch.

Mission Demonstrates New Packaged Gas Turbine Power

Packaged gas turbine power was demonstrated recently by Mission Manufacturing Company at its Houston plant. Mission packages gas turbines in the 35 to 850 horsepower range manufactured by AiResearch Manufacturing Company of Arizona, a Division of The Garrett Corporation.

Three general types of AiResearch gas turbines are used in Mission package. One type supplies energy in the form of compressed air. Another, in the form of shaft power. And the third type provides shaft horsepower and compressed air power simultaneously, or either form of power independently and interchangeably.

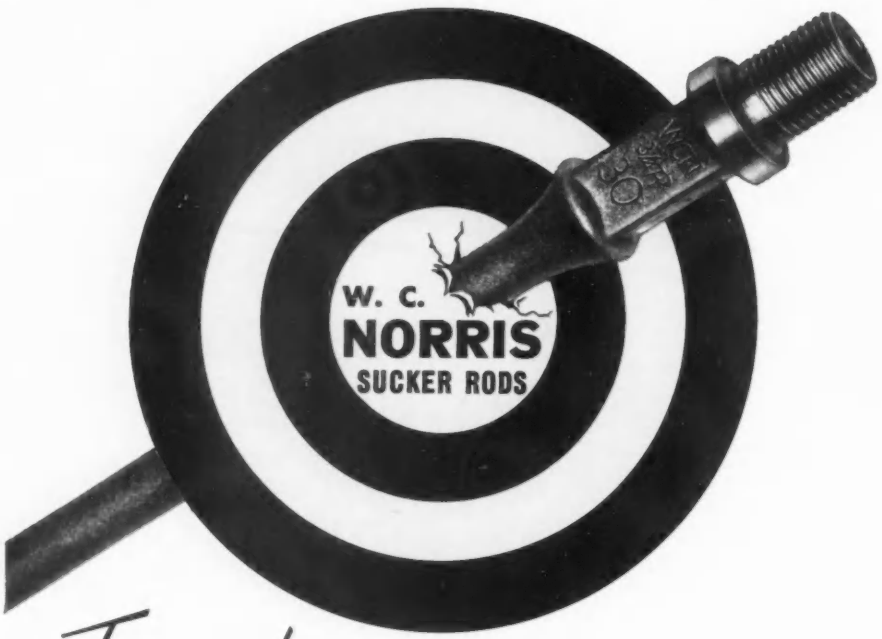
Gas turbines can provide high-pressure, high-volume fluid pumping with a compact, portable unit. The unit is used to provide first-stage air at 350 psi for air-drilling rig using the Mission Hammerdril.

Mission packaged "round" power units are equipped with fully automatic controls which properly sequence starter operation, fuel control and ignition, thus, providing a stable automatic starting cycle requiring only a single starter switch.

Magcobar Now Operating New Iranian Facilities

Start up of new drilling mud production facilities operated by Sherkat Sahami Magcobar Iran, a newly organized affiliate of the Magcobar Division of Dresser A.G., Veduz, has been announced.

Headquarters of the new firm are on Eisenhower Avenue in Teheran. A completely integrated drilling mud company, it operates a recently constructed production facility at Parandak, approximately 100 miles south of Teheran, and newly opened barite mining properties located in the Alborz Mountains, north



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BETTER PERFORATING

CEMENT WITH STRATA-CRETE 6

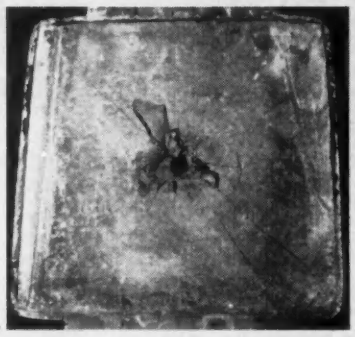
1. 2% Bentonite—Portland Cement cured 7 days at 120°F. Note the widespread cracking and shattering of regular cement due to perforation.

2. 1:1 Bulk Mix
1 cu. ft. Portland Cement—1 cu. ft. Strata-Crete 6—2% Bentonite. Cured 7 days at 120°F.

Under same test conditions, STRATA-CRETE 6 cement did not crack or shatter.

3. & 4. Slurries with and without STRATA-CRETE 6 were set in steel drums and then perforated under critical test conditions. When the steel drums were cut away with an acetylene torch, the regular cement (left) fell apart.

The STRATA-CRETE 6 cement (right) remained intact with clean holes and no noticeable cracks.



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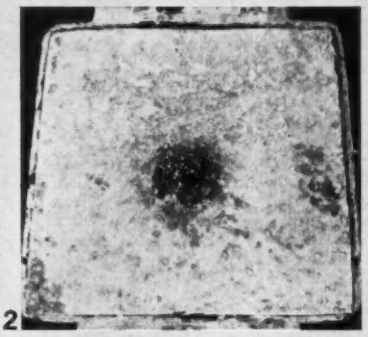

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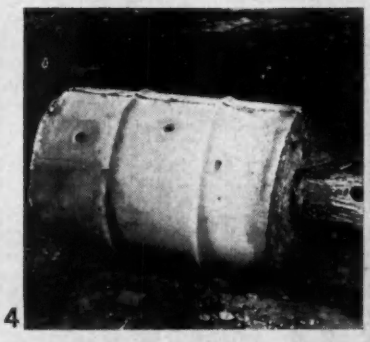

4

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CLEAN, NON-SHATTERING PERFORATIONS
Resilience of Strata-Crete 6 cement allows maximum charge perforating without cracking or shattering.

LIGHT WEIGHT
Strata-Crete 6 provides practical slurries weighing only 12.5 to 14.5 lbs/gal. at 3,000 psi.

BEST BRIDGING QUALITIES
Independent laboratory tests have proved Strata-Crete 6 has best bridging properties of any available additive.

GOOD EARLY STRENGTH
means quicker completions.

EASY PLACEMENT
with normal pump pressures.

LOW PERFORMANCE COST
because, dollar for dollar, you get more fill-up than with most other materials.

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Great Lakes Carbon Corporation

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Phone: CApitol 5-6501 • HOmestead 5-9453 • MOhawk 5-5807
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Suppliers' notes

of Karaj, and other mining properties in the Seveh area, south of Parandak. The new organization is staffed by personnel trained and experienced in modern drilling mud products and techniques.

Daniel Orifice Appoints European Representative

Daniel Orifice Fitting Company, Houston, has appointed the American Premaberg Company, Inc., and its subsidiary companies as exclusive sales representatives for Daniel products in the following countries: England, France, The Netherlands, Germany, Austria, Italy, Spain and Algeria.

The agreement became effective March 1, for the New York headquartered firm.

New Cardwell Workover Rig Added to Kenyon's Array

Kenyon's Oilfield Servicing Co., Ltd., Edmonton, Alta, have announced the recent addition of a Cardwell KM-210-56 to their array of workover rigs.

Cardwell KM-210 is a "drive-in" servicing or workover unit designed for competitive servicing in the 7,000 foot to 12,000 foot range. The new Kenyon unit is equipped with a Cardwell Model 180-96 foot telescoping structural mast with working hook load capacity of 180,000 pounds. The Cardwell KM-210 exhibits excellent roading characteristics and drastically cuts moving-in and rigging-up time.

Kenyon's Oilfield Servicing Co., Ltd., are affiliated with Kenyon's Drilling & Servicing, Ltd., with Fin C. Lineham, president, and Glen Baumbach, vice president.

Reed Roller Bit Promotes Robert Walker

Robert L. Walker has been named executive vice president of Reed Roller Bit Company and all its subsidiaries. At the same time, R. R. Wright was appointed vice president and general manager of the firm's Cleco Division.

Walker, manager of Cleco since September, had previously served as coordinator of engineering operations with sales. Before joining Reed he was with Shell Oil Company. Wright has been chief engineer of Cleco Division for several years and with Reed Roller Bit about 20 years.

Thermco, Inc., Is Newly Organized Oklahoma Firm

Three Tulsa engineers recently announced the formation of Thermco, Inc., to design and fabricate process heat transfer equipment for the petroleum, petrochemical and atomic energy industries.

Principals in the new firm are William H. Mason, John J. Griffin and Edwin H. Stabert. Business and engineering offices are located at 801 West Twenty-Third Street, Tulsa.

Over 1100 field installations
... less than 2% maintenance!

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FRICTIONAL TUBING ANCHOR
U.S. Patent No. 2,874,783

- Smooth gripping members hydraulically actuated
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- Completely automatic
- Calibrated holding power
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- Large by-pass area
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- Installed above pump; automatically "sets," holding tubing in natural tension
- No drag on casing going in hole or coming out unless tubing is pulled "wet"
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Compensates both up and down

Complete range of sizes for 4½" to 11¾" API Casing. Write for complete information.

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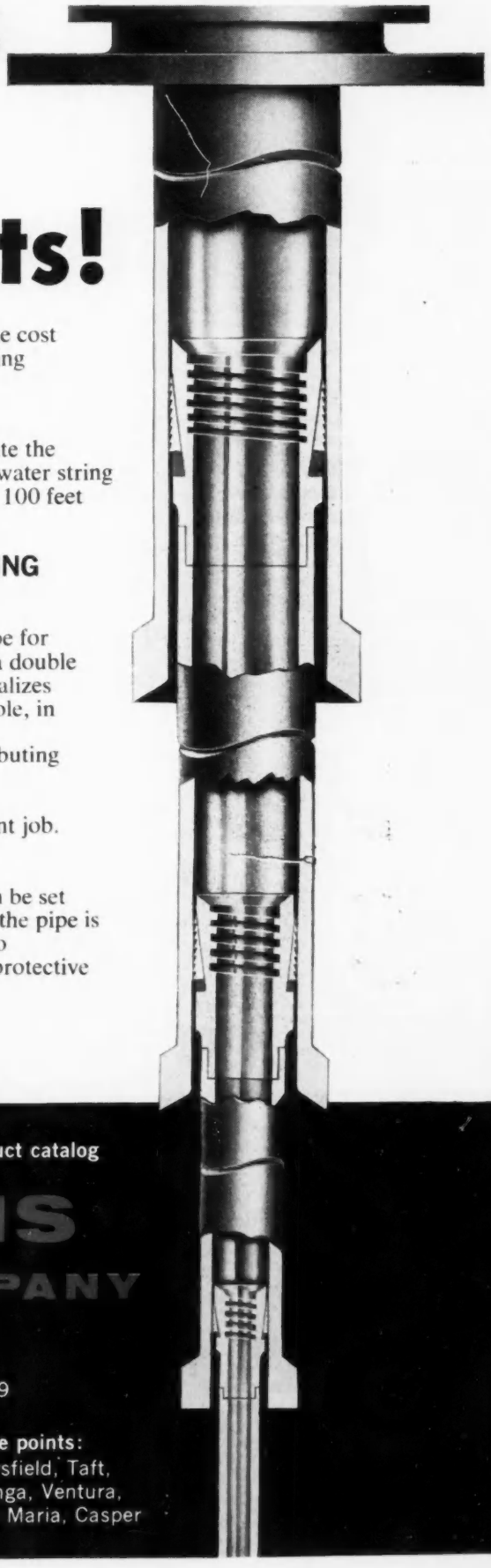
Standardize on Burns Casing Hangers and SAVE Completion Costs!



Today's allowables make it imperative to reduce the cost of oil well completions. Keep up your present drilling commitments with less investment per well.
Use a Burns Casing Hanger!

The displacement of the slip is arranged to distribute the load uniformly around the water string, giving the water string maximum protection. Suspend on bottom, overlap 100 feet in the protective string and cement the overlap.

ELIMINATE THE HAZARD OF CASING CONTACTING THE WALL OF THE HOLE

Get a uniform annular space around the casing shoe for cementing in high angle holes by suspending with a double Slip Burns Casing Hanger. Suspended casing centralizes itself and is perfectly aligned with the axis of the hole, in tension, free of bends, assuring a good cement job.
Each slip carries its own load, independently distributing the load equally over the entire slip area.
Circulation grooves milled in the body reduce the velocity around the hanger, assuring a better cement job.
Cementing the well can be done either before or after the hanger is released.
SAFETY: The double-slip Burns Casing Hanger can be set with the proper stretch on the casing, even though the pipe is frozen, by rotating the running-in string six turns to the right. This allows the slips to raise against the protective string and suspend the frozen casing properly.

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OD—2, 2½, 3, 3½, 4¼, 5, 5½, 7 in.

Lengths—20, 25, 30 ft. for 3" OD and larger pumps. 20 and 25 ft. for 2½" pump. 20 to 24 ft. for 2" pump.

Composite Catalog, Page 3688
Write for descriptive price list

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SQUEAKS

From the Bull Wheel

Better Luck, Next Time

First Hunter: "Good gosh, you almost shot my wife!"

Second Hunter: "Did I? Well, here, have a shot at mine."

Well, It's Your Problem

Wife: "Wake up, John. There's a burglar going through your pockets!"

Husband: "Oh, you two fight it out between you."

A Do-It-Yourselfer

"Look, Ma!" cried the little elephant as he pressed his head against a tree and stretched one hind leg straight out behind, "I'm a bookend!"

A Believer in Advertising

Seeing a sign at a movie house, "Servicemen, 25 cents," Tisshe Lou Ellamae walked over, put down a dollar and said, "Four marines, please."

Confucius Say

"The average husband is proof enough that a woman can take a joke."

I Shall Return

A construction worker, during a bitter cold spell in Montana, climbed down from his rig. "I'm going to get my safety helmet," he explained to the foreman.

"Where is it?" asked the foreman.

Without looking back, the worker replied, "In Florida."

In Time of Need

"Could I have the day off, sir, to help my wife with her spring house cleaning?"

"No, I'm afraid not."

"Thank you, sir, I knew I could count on you."

Remember When . . .

You could take a nickel's worth of candy and pass it around?

Whenever You're In Doubt

Two tourists on their way to Hawaii got into an argument over how to pronounce it. One said it was "Hawaii." The other insisted it was "Havaii." They bet $100 on their opinions.

In order to determine the winner, they decided to ask the first native they saw upon landing in Honolulu. The first fellow they met at the airport had a deep suntan and they put the question to him: "Is it Hawaii or is it Havaii?"

"It's Havaii," said the man.

"Thank goodness, now we know," said one of the men. "You're the first native we met. How long have you been here?"

"Two veeks."

"Okay, Okay! You can have the drilling contract."

Modern Girl

A girl looking for a husband has to know how to play tennis, golf, piano and dumb.

A Helpful Burglar

The burglars had tied and gagged the cashier after extracting the combination to the safe and had herded the other employes into a separate room under guard. After they had rifled the safe and were about to leave the cashier made desperate pleading noises through the gag. Moved by curiosity one of the burglars loosened the gag.

"Please!" whispered the cashier, "Take the books, too. I'm $6,500 short."

How Else?

"When it comes to eating, you'll have to hand it to Venus de Milo."

"Why?"

"How else could she eat?"

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PERFORATING SERVICES

your best bet for best production

Here's the most complete, most efficient line of perforating services available to the oil industry – all designed with one objective – to get more oil, *best* possible production!

Choice of the type perforating process to be used depends on the nature of the formation to be penetrated and the method of well completion; whether in full size casing, thru-tubing or in slim holes.

At McCullough you'll find bullet and jet guns, in a variety of types and sizes, to handle every requirement – quickly, efficiently and profitably – your *best* bet for *best* production!

FOR PERFORATING IN CASING

McCULLOUGH BULLET GUNS – World's hardest shooting bullet guns. Best available perforating process in all formations except extra hard.

McCULLOUGH GLASS JET GUNS – Most versatile and efficient of all jet casing perforators. Deep penetrating, carrot-free, junk-free. Uses flexible, retrievable Steel Strip Carrier. Gets best results in hard formation.

McCULLOUGH TUBULAR CASING JET GUNS – Star Jet, DuPont, Dynajet and Super Dynajet charges are available in most areas to meet varying well conditions.

TORPEDO JET GUNS, expendable type perforators for cased and open hole operations. Offered in limited areas.

FOR THRU-TUBING AND SLIM-HOLE PERFORATING

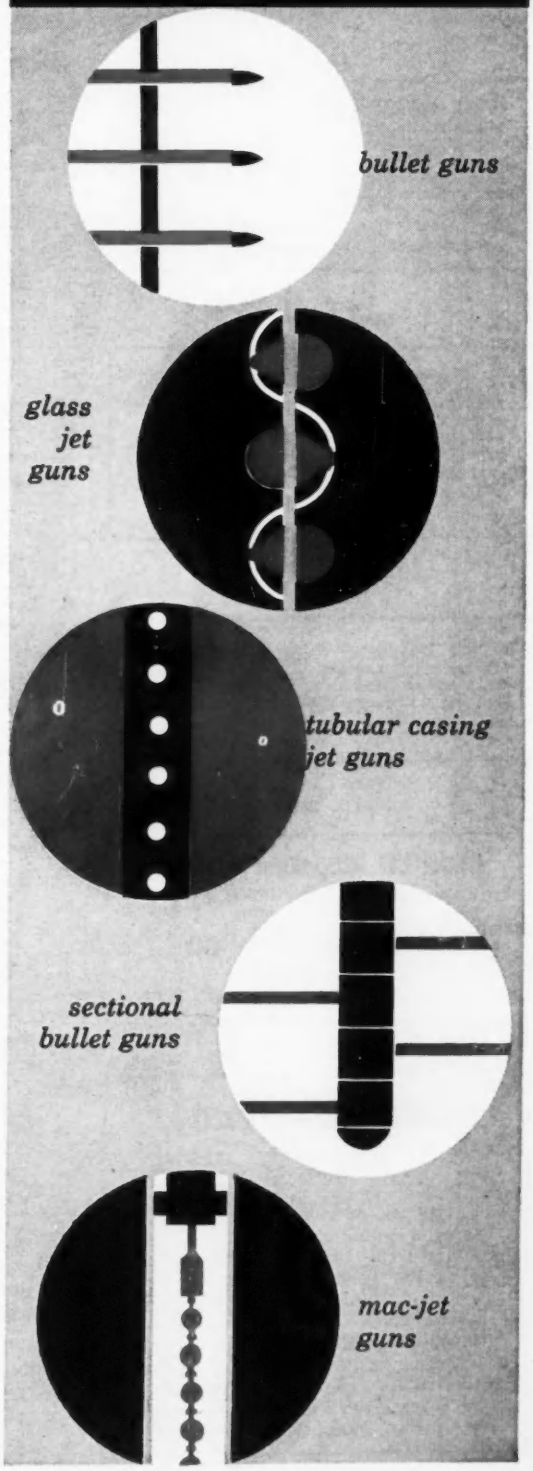
McCULLOUGH SECTIONAL BULLET GUNS – Only small diameter bullet guns made. Sizes are 1⅛", 1¾" and 2¼" OD. Backed by a record of more than 20 years of fine performance.

McCULLOUGH MAC-JET GUNS – Finest and most advanced of all small diameter, expendable jet guns. Features include enclosed firing system, minimum debris, deep penetration, high well flow index, carrot-free. Widely used in both thru-tubing and slim hole work.

OTHER SMALL DIAMETER GUNS include the **LINK JET** and **TORNADO JET,** expendable thru-tubing perforators; and the **SIDEWINDER,** a retrievable jet perforator for slim hole operations.

SPECIAL APPLICATIONS

McCULLOUGH FOUR-WAY SQUEEZE JET GUNS – designed to assure even distribution of cement around casing. **FRAC-JET** – fires eight jets on a horizontal plane for fracture placement.



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Thompson Guest Speaker at Los Angeles NOMADS Meeting

W. A. Thompson, Alliance Companies, was guest speaker at a recent meeting of the Los Angeles Chapter of NOMADS. Guests present at the meeting included (front row, left to right) Thompson, who spoke on India; Erle Hume of Caltex from Sumatra; Lee White of D.M.J.M. from Thailand; H. G. Karnes of R. M. Parsons from Ethiopia, and Wm. M. Hendricks, ex K & C in London. (Back row, left to right) Forrest Harrell and J. O. Jackson of Camdrill from Libya; James E. Hooper of Drilexco from Brazil; Albert Jensen of D & E from Portuguese Guinea, and Elmer V. Kimble of Haney & Williams from Brazil.

NEW books, maps and movies

ROTARY DRILLING HANDBOOK, Sixth Edition, Palmer Publications, J. E. Brantly, For Sale by Gulf Publishing Company, 3301 Allen Parkway, P.O. Box 2608, Houston 1, Texas, $12.50.

This is the sixth edition of this handbook, the first having been published in 1936. The first edition originated from a paper prepared for the 1935 annual meeting of the API. The paper was too long and too late and therefore was not presented as planned. It was expanded, tables, formulas and graphs were added and it was published as "Rotary Drilling Handbook" in 1936.

This new sixth edition has been completely re-written in the light of new developments in equipment and techniques so that it is 20 percent larger than its immediate predecessor which won for Brantly the coveted medal of the Society of Petroleum Engineers of AIME.

MUNGER MAP BOOK OF CALIFORNIA AND ALASKA FIELDS, A. H. Munger, 5865 West Boulevard, Los Angeles 43, $20 plus 4 percent sales tax.

The 1961, Fifth Edition, Munger Map Book of California and Alaska oil and gas fields contains 220 pages showing nearly 400 California and Alaska fields. It measures 12 by 18½ inches; is metal spiral-bound along the top for easy opening and to lie flat on a desk. All maps, including new fields and areas, are updated to March 15, 1961. A clear vinyl map scale, with 10 map scales, is included with the book.

A HOLE IN THE BOTTOM OF THE SEA, Doubleday & Company, 574 Madison Avenue, New York 22, N. Y., Willard Bascom, $4.95.

This is the first book to tell the story of the Mohole Project. It explains the many fields, geology, oceanography, engineering, modern drilling technology and others that are being brought to bear on the problems inherent in deep, oceanic drilling.

Willard Bascom, the director of the Mohole Project, discusses in detail why the Mohole is far more than a stunt. He recalls the fictional explorations to the earth's interior by Jules Verne and Sir Arthur Conan Doyle; shows how the geological and geophysical characteristics of the earth have developed over the ages, and explains volcanoes, earthquakes, seismology, geology, oceanography and many other things.

SURVEY OF OILS 1960, The Financial Post, 481 University Avenue, Toronto 2, Canada, $4.

This basic reference book on oil and gas in Canada comments that the industry has passed through the embryo stage of finding large sources of supply. The problem of lining up large long-term market growth is being tackled vigorously.

This 248-page survey reports on thousands of companies, includes balance sheets, directors, property holdings and other information useful as reference.

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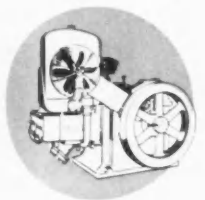
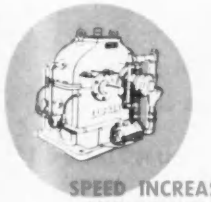


GAS ENGINES

TRAILERS



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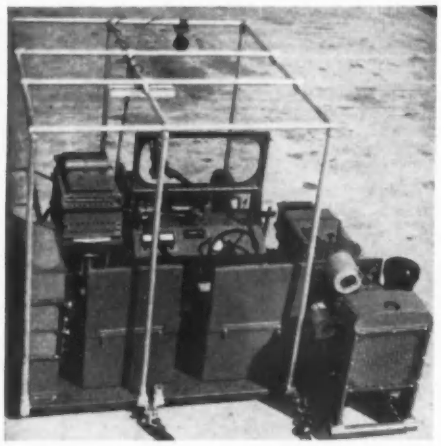
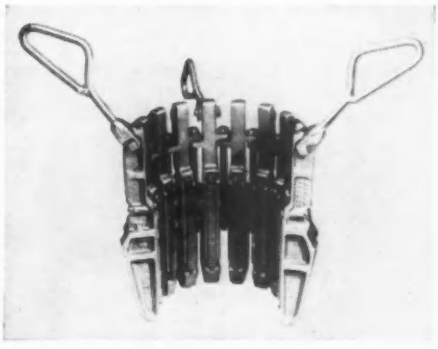
NEW equipment and services



Air-Borne Logging Unit

This new, light-weight air-borne unit supplies logging and completion services to remote and inaccessible well locations. Chief feature of the new design is the division of the complete unit into three principal sections, each weighing 2,000 pounds or less. Components consist of recording equipment, winch and engine drive sections, can be easily and quickly assembled at the well. New multiconductor logging cable of small diameter holds down gross weight, but allows running of all types of services to depths as great as 11,000 feet. (Schlumberger Well Surveying Corp. Supplements data on Pages 4849-4868, 1960-1961 Composite Catalog).

For more data, circle E1 on postcard



Drill Collar Slip

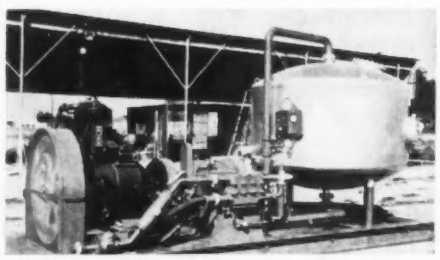
A self-aligning, multi-segment drill collar slip that adjusts automatically to a full, safe grip on collars is now available. Wooley Type A compensates for collar wear in two ways: Strong, multi-segment design wraps slip firmly around the collar; sectional inserts adjust vertically to drill collar irregularities so that *every tooth* grips the collar. (Wooley Tool & Manufacturing Co. Supplements data on Pages 5873-5876, 1960-1961 Composite Catalog).

For more data, circle E2 on postcard

Horizontal Plunger Pumps

An addition to its Series 3400 horizontal plunger pumps has been developed by the manufacturer to provide high pressures in small volume waterflood projects and well servicing operations. Gaso Figure 3467 is a 1¼-inch to 2-inch by 4-inch pump with a high pressure fluid end and a single suction. Has a maximum speed of 31.5 bph at 3,500 psi with 1¼-inch plungers, and 81 bph at 2,000 psi with 2-inch plungers. (Gaso Pump & Burner Mfg. Co. Supplements data on Pages 2053-2076, 1960-1961 Composite Catalog).

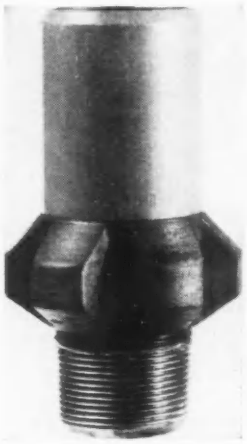
For more data, circle E3 on postcard



Compact Waterflood Unit

This compact packaged waterflood skid-mounted unit is built around the new J-50 Triplex pump which was direct-connected to a slow-speed gas engine. Pump capacity can be varied from maximum of 4,480 bpd at 560 psi, to 1,530 bpd at 1,645 psi. Ajax DP-60 9½-inch by 12-inch single cylinder, two cycle engine is direct-connected by Thomas flexible coupling to the Triplex and drives a centrifugal 600-gpm backwash pump and 150-gpm transfer or filter pump by means of V-belt drives from the engine clutch shaft and Triplex pump shaft extension. (The National Supply Co. Supplements data on Pages 3849-3976, 1960-1961 Composite Catalog).

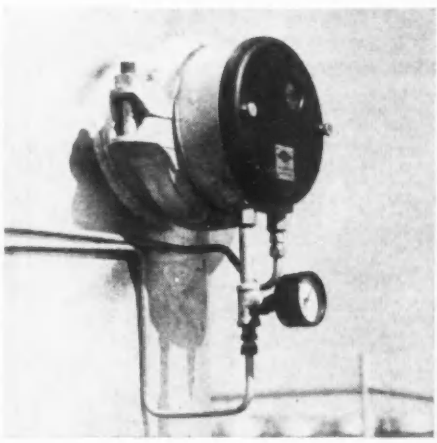
For more data, circle E4 on postcard



Saver Sub-Centralizer

This tool is a combination saver sub-centralizer for oil well tubing used in both tubingless completions and normal tubing-in-casing completions. It is run in the string by making up between the tubing and the tubing collar on every joint or as many joints as desired. Advantages: permanently made up in string and cannot be moved; no clamps required; no time lost in running and centers tubing in casing. (D.M. Best Co. Supplements data on Page 651, 1960-1961 Composite Catalog).

For more data, circle E5 on postcard

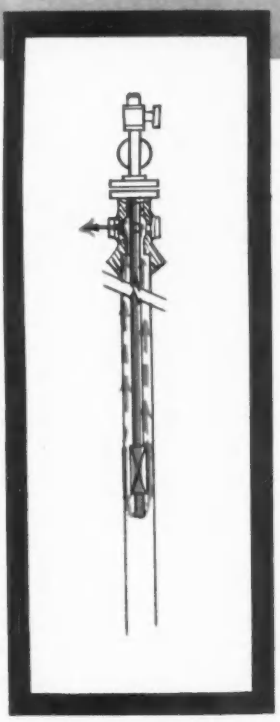


Metering Separator Control

This Paraquip P-6000 single float metering separator control is designed for economy in the design and construction of the vessel without sacrificing any of the features that give maximum reliability of operation. Paraquip P-6000 is completely contained in the housing. Control is installed in the vessel through a 6-inch standard pipe grooved nipple welded through the side of the vessel. The control may be used at any vessel pressure to 300 psi. (Paraquip, Inc.).

For more data, circle E6 on postcard

Drilling and Completion with Inert, Low-Cost Liquid Nitrogen



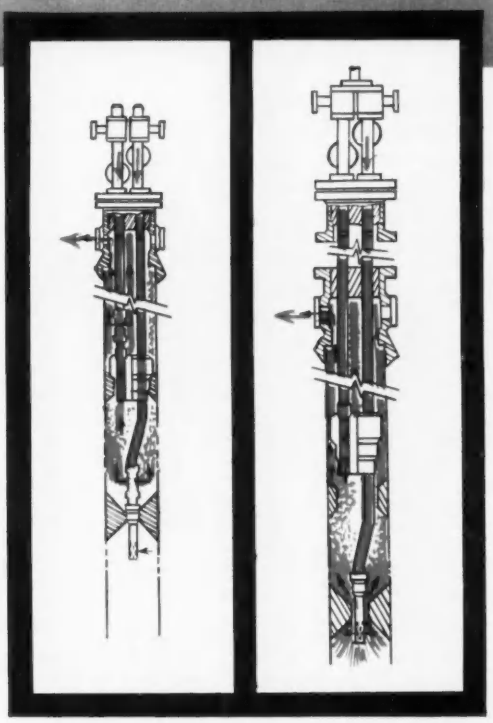
DISPLACEMENTS

Use of nitrogen eliminates swabbing, preventing possible loss of tool in hole and/or damage to tubing. Gas can be bled to air and well brought in under full control.

Old wells can be flushed of dead oil or other reservoir fluids without additional equipment.

COMPLETIONS

Drilling fluids can be displaced from the well without damage to formation and in minimum time.

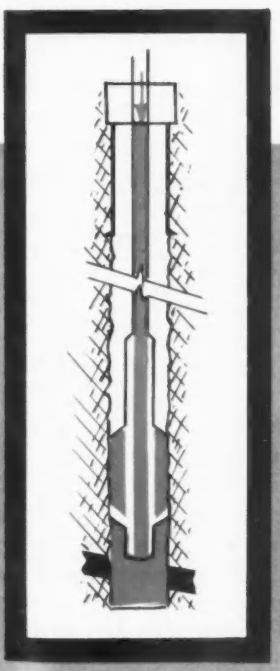


CORROSION INHIBITION AND PARAFFIN REMOVAL

Injection of corrosion inhibitors and paraffin solvents with nitrogen gives direct contact to the surfaces being treated for more efficient service.

ACIDIZING AND FRACTURING

Use of nitrogen as a cushion and carrier during acidizing and fracturing operations prevents acid dilution formation blocking by fluids. Lower hydrostatic weight permits easier flushing following frac jobs and increases penetration of frac stream as much as threefold.



TESTING

More effective drill stem testing is possible when nitrogen is used to displace drilling fluids and to pressure up the drill string. Formation samples are not contaminated and testing equipment operates safer and easier.

DRILLING

Use of nitrogen in drilling fluid or to nitrify the drilling mud results in faster drilling without danger of down hole explosions or contamination of possible production zones.

NOWSCO service trucks and trained operators are stationed at Houston, Corpus Christi, Perryton, Odessa and Orange.

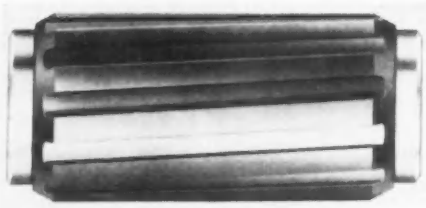
Watch for announcement of additional locations shortly.

NITROGEN OIL WELL SERVICE COMPANY

3602 W. 11th Street, Tel. UN 4-0965, Houston, Texas

Other applications available on inquiry.

New equipment



Sucker Rod Coupling

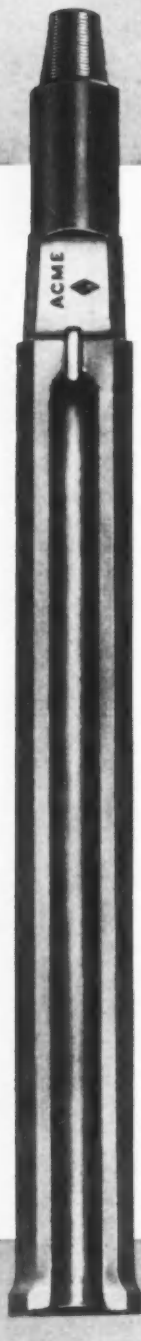
This new sucker rod coupling has been designed to reduce wear on couplings and tubing while at the same time lowering frictional drag in the well. Nyloglide couplings have a special thermoplastic jacket molded securely on their outer diameter. Jacket, with spiral flutes on a 15-degree helix angle in 3.5 inches for complete coverage of the tubing surface with no impedance of fluid flow, is compounded from a special nylon material containing fiber glass for added strength. (Liberty Mfg. Co. of Texas. Supplements data on Pages 3322-3323, 1960-1961 Composite Catalog).

For more data, circle E7 on postcard

Power Tubing Tong

This new hydraulic power tubing tong with front-end controls was especially designed to give more speed and efficiency. Features include: front-end controls which cut operating time; new rugged planetary-type gear box; new sturdier special bronze drag shoe that gives longer wear; snap-out stainless steel jaw pins easily released by pressing a center button, simple, fast jaw change-over that fits tong to various tubing sizes. (Hillman-Kelley. Supplements data on Pages 2515-2524, 1960-1961 Composite Catalog).

For more data, circle E8 on postcard



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PERFORMANCE

ACME Drilling BITS

CARBON OR ALLOY STEEL

Known the world over for the best in Cable Tools, ACME builds bits to the strictest specifications.

From steel mill through forge shop, in all steps of manufacture, ACME maintains rigid quality control. Chemical analysis, physical quality, automatic temperature and atmosphere in furnaces, heat treating, die forging and inspections all point toward one goal — bits that drill more footage per dressing — outstanding performance at lowest possible drilling cost.

ACME offers two types of drilling bits, both shipped semi-dressed with sawed cutting edge.

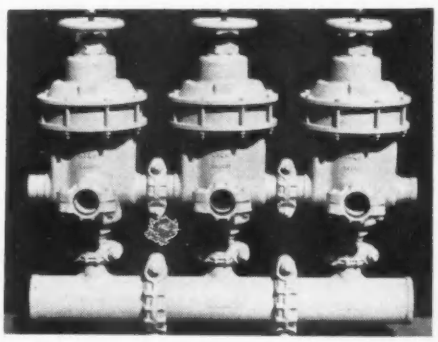
CARBON STEEL, the standard for years with many drillers.

ALLOY STEEL, deep hardening, stays sharp longer, pioneered by ACME in 1935.

Sold through dealers everywhere

Write Dept. 61 for Tool Catalog.

ACME FISHING TOOL CO.
Box 860
PARKERSBURG, WEST VIRGINIA



All-Purpose Manifold Valve

These full opening three-way valves are designed for use in the construction of test-production headers in lease automation system. Are available in both two position and three position. Internal parts and diaphragm housings of manifold valves are interchangeable with stock Parquip three-way valves. All valve seats have full line size flow areas; diaphragm areas are large enough to positively actuate the valves. When engaged, valve cannot be moved from its position by pressure on the diaphragm. (Paraquip, Inc.).

For more data, circle E9 on postcard

Hole Enlarging

This is just one of the three *families* of Grant Tools made for reaming, hole enlarging and stabilizing. For full information on these, and a wide range of other down-hole and surface tools made by Grant, send for your copy of the complete Grant Catalog today, or see the Grant section of Composite Catalog!

You can get from Grant!

Every hole enlarging job presents its own special set of conditions. That is why Grant, with more experience in this highly specialized field than any other manufacturer, has engineered specific tools for *your* particular job. For opening rat-holes . . . enlarging hole for the casing string . . . under-reaming before cementing—in any well—Grant's 30 years of specialization have produced the right tool for the job at hand.

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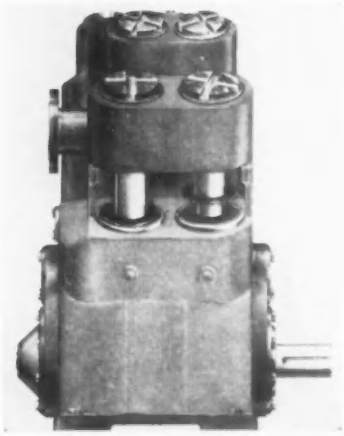
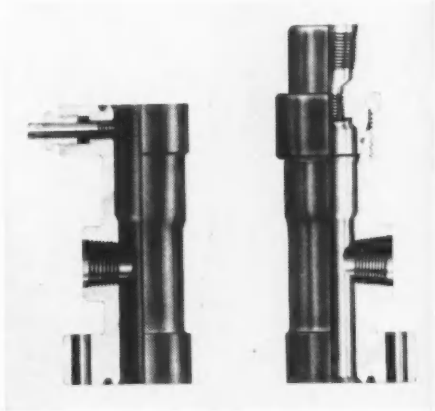
New equipment



Quadruplex Plunger Pump

New Barry V45 pump is now available in several sizes on three frame sizes with six models. Design features a suction and packing arrangement for handling fluids beyond the range of any power pump without pressurized suction. Features include: Suction valves placed so that fluid never stops nor changes direction while being pumped; non adjustable packing with rigid metal body holds the lip in place so packing cannot flow; power frame has one-piece cast construction for maximum rigidity. (W. R. Barry Pump Company).

For more data, circle E10 on postcard



New Type Tubing Heads

These new O-C-T tubing heads were designed to meet current needs for multiple and tubingless completion wellhead equipment. Type M (macaroni) can be supplied with either flanged or threaded connections on top and bottom. Crescent flanges, tri-flanges and quadruple flanges also are available. Type M tubing hangers also have been introduced which include a threaded hanger, threaded hanger with back-pressure valve grooves and stripper hanger. (Oil Center Tool Co. Supplements data on Pages 4053-4092, 1960-1961 Composite Catalog).

For more data, circle E11 on postcard

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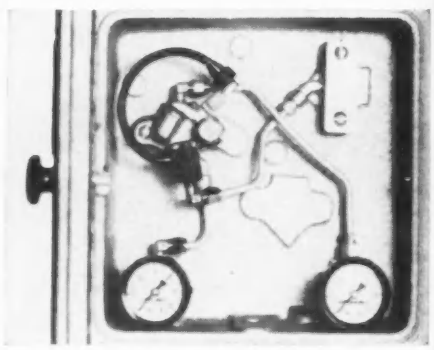
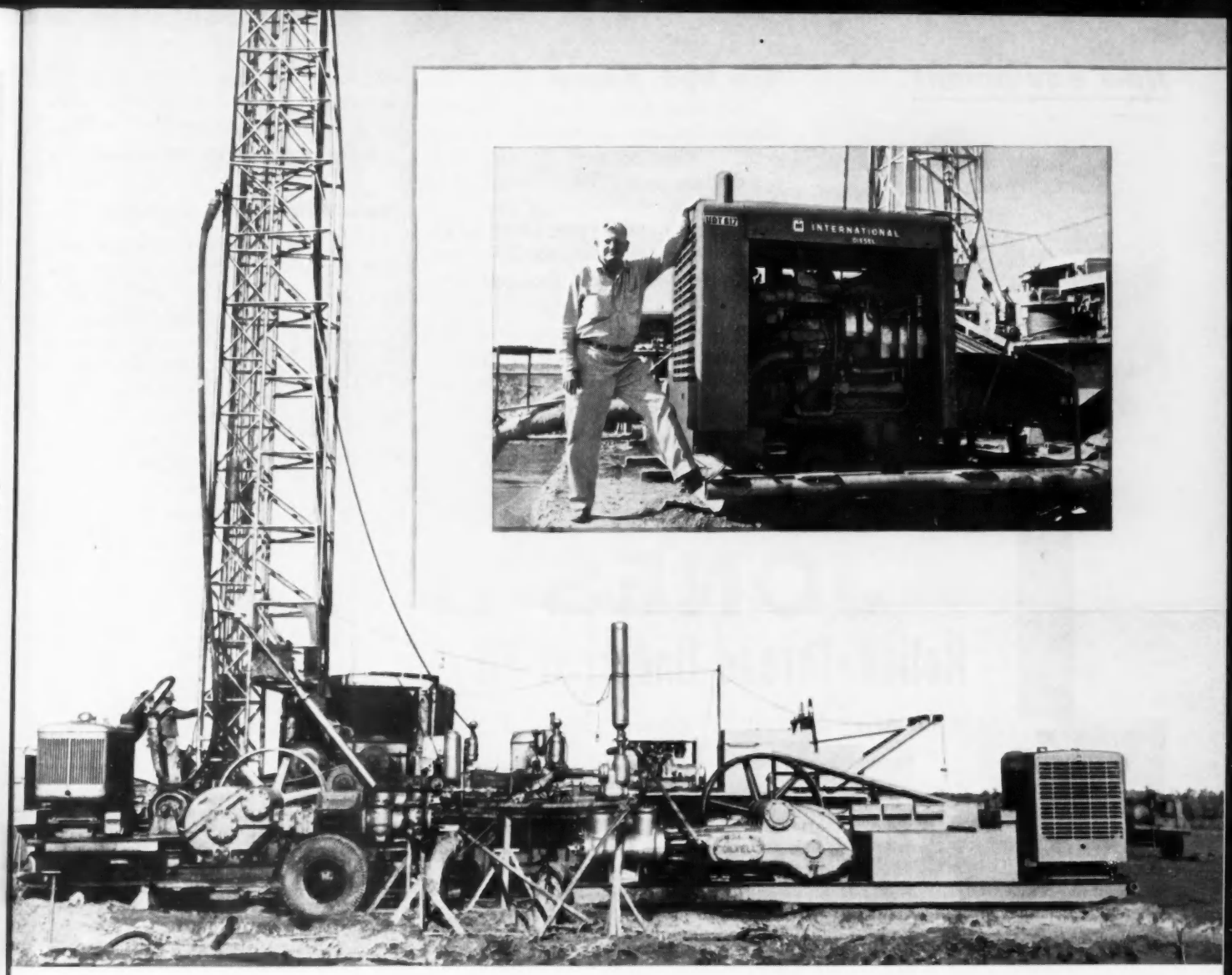


Pressure Control Pilot

This new type of "PC" Pressure Control Pilot is available for use in conjunction with diaphragm motor valves for on-off flow and pressure control applications. Pilot is recommended where two position control is preferable to throttling control. "PC" pilot and case is of anodized, Corrosion resistant, all aluminum and stainless steel construction. Assembly may be top-mounted on a motor valve or panel-mounted. (Macco Oil Tool Co. Supplements data on Pages 3448-3450, 1960-1961 Composite Catalog).

For more data, circle E12 on postcard



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"I have worked the oil fields 35 years, and haven't found anything harder on men and equipment than just plain drilling. I like International engines for their toughness and ability to take rough use day after day and keep going. They can really take it!" —Andrew Dickens, Partner, Valley Oil Co.

Ask an old pro if you want the lowdown on power efficiency in the oil fields. Andrew Dickens, Valley Oil Co., Cottula, Texas, has been in the business for 35 years, and he knows a lot about engines. Mr. Dickens backs up his preference for International with facts. The Valley spread shown above is powered by four IH engines—a new UDT-817 and a UD-525 on mud pumps, plus two older and still efficient IH diesels on drill and draw works.

Experience is important to an engine builder, too. It's no coincidence that International, the world's oldest and largest producer of heavy-duty engines, also produces the most efficient power for heavy-duty applications. Thousands of customer records, kept over the years, show that International engines work harder and last longer on the tough jobs!

Your power requirements can be quickly and easily handled with a call to your nearby International Engine Dealer or Distributor. He has complete information on the 35 models—16.8 to 385 max. hp.—in the International line. Call him today!

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ENGINES

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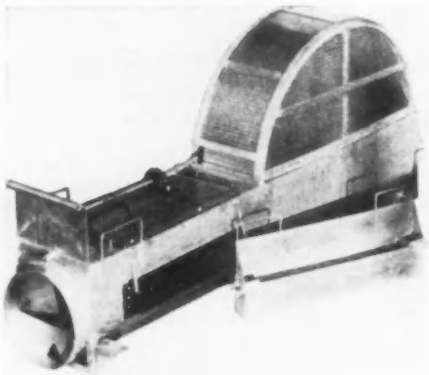
A COMPLETE POWER PACKAGE

New equipment



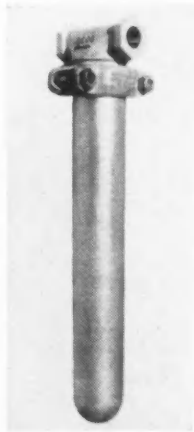
New Ditch Magnet

This new Kirby Model F Ditch Magnet has been developed for magnetic removal of steel cuttings from the drilling mud system. Installed in the mud system between the shale shaker and working pits, Ditch Magnet removes metallic particles suspended in the mud, as the mud flows through the unit. Adjustable wings at the entrance to the unit direct mud flow through the housing in which a powerful magnetic element is suspended to create the magnetic field. (K & G Oil Tool and Service Co., Inc. Supplements data on Pages 3104-3107, 1960-1961 Composite Catalog).

For more data, circle E13 on postcard

New Filtration System

This new adsorbent filtration system for waterflood injection or disposal wells, using a silicon cartridge that can be backwashed innumerable times has been perfected. Silica cartridge, ranging from 10 to 75 micron sizes, has an indefinite lifetime when given proper maintenance. New Deco filtration system promises vast savings by eliminating down time lost in changing cartridges and reducing costs of repairs and meter parts. (Frank Wheatley Corp. Supplements data on Pages 5617-5636, 1960-1961 Composite Catalog.)



For more data, circle E14 on postcard

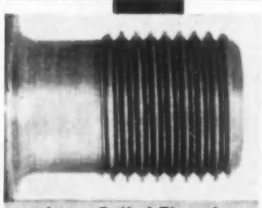
. . . another Jones First

JONES

Rolled-Thread Undercut Pin

Greater Strength–Easier Make-Up

API Cut Thread
Most susceptible to fatigue is thread root area, where notch effect exists.



Jones Rolled Thread
Mirror-like surface aids application of make-up torque to pre-stress joint.

Rolled threads, made by cold working or displacing the metal into the thread form, are stronger at the very point where most cut-thread pin failures originate. Steel fibers and grain are rearranged to follow the thread contour, providing a dense structure at the critical thread root . . . added strength where it is needed most. Additional fatigue resistance is obtained by undercutting the pin shank, thereby eliminating the run-out thread and improving the elasticity of the joint. The superior finish and gauge tolerances attained in Jones rolled-thread sucker rod pins reduce friction and make possible greater prestressing of the joint with equal torque.

Ask your Jones representative for complete information on this new Jones development.

THE S. M. JONES COMPANY

Division of Buffalo Eclipse Corporation
General Office and Factory: TOLEDO, OHIO
Sales Office: Enterprise Building, TULSA, OKLAHOMA
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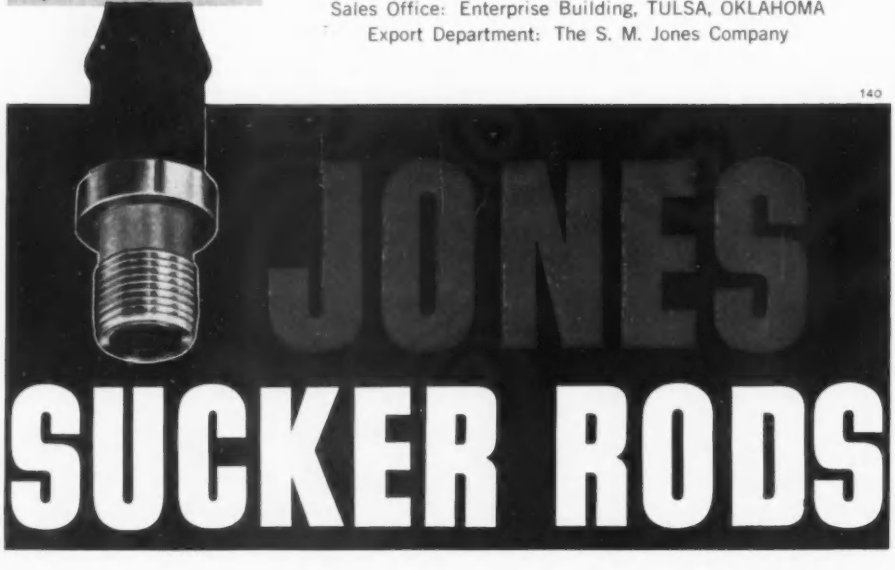

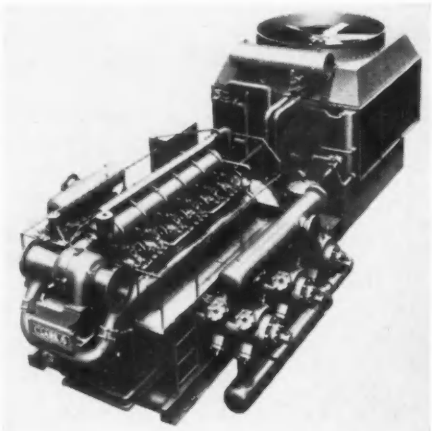

New Packaged Compressor

This packaged field compressor provides up to 1,000 bhp. It is mounted on a single skid only 35 feet long, complete with radiator, scrubber and accessories. Units are V-design for maximum horsepower square foot of skid or floor space. Wide spacing between compressor cylinders makes them very accessible and permits the use of large compressor cylinders when required. (Clark Bros., Co., One of The Dresser Industries. Supplements data on Page 1369, 1960-1961 Composite Catalog).

For more data, circle E15 on postcard

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Camco, Inc.....DA 5-7134
FULLETON, CALIFORNIA—Dyna-Log...LA 6-1184
GLENDIVE, MONTANA—C. A. White..EM 5-3833
HOBBS, N. M.—Horne Serv. Co.....EX 3-5396
HOUMA, LA.—Camco, Inc....UP 3-7330, UP 2-3804
Klein Deco Wire Line.....UP 2-4337
HOUSTON—Long Line Prod. Control.....GR 3-5739
Mid-Western Well Serv. Co.....RE 4-4337
KERMIT, TEX.—Kuykendall Wireline....JU 6-4538
Mid-Western Well Serv. Co.....RE 4-4262
LAFAYETTE, LA.—Camco....CE 5-3124, CE 5-6687
LIBERAL, KAN.—Rainbo Serv. Co.....MA 4-3598
MIDLAND, TEXAS—Luccous Serv.....MU 2-8311
NEW IBERIA, LA.—Cardinal Wireline...EM 4-5165
Klein Deco-Wire Line.....EM 4-0471
ODESSA, TEXAS—Kuykendall Wireline..FE 7-7210
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co.....ME 4-2131, ME 4-0105
PETTUS, TEXAS
Eddie Jones Eng. Co. Pettus 16-Beeville FL 8-1218
VICTORIA, TEXAS—Camco, Inc.....HI 3-9251
WICHITA FALLS, TEXAS
Eads Eng. Serv., Inc.....776-0931
WILLISTON, N. D.—C. A. White.....GR 3-6555
EDMONTON, ALBERTA, CANADA
Camco, Ltd.....GE 9-3641, GE 9-3124
VENEZUELA:
Anamio Anzoategui—A-Z Export, S.A.
Maracaibo—A-Z Export, S.A.....6982-3480
Puerto La Cruz—A-Z Export, S.A.....86-332...
Anzoategui W. L. Service..24-353

New equipment

New Line of Rock Bits

New ST-3 rock bits are designed for drilling straighter holes. Manufacturer claims harder formations than normally used can be drilled with a coarser tooth thereby speeding drilling rate of formation. ST-3 maintains straight hole when going through streaks interspersed with soft formation. ST-3 rock bits are available in both regular and jet types. (Globe Oil Tools Company. Supplements data on Pages 2105-2124, 1960-1961 Composite Catalog).

For more data, circle E16 on postcard

Bull-Jet Perforators

A new Bull-Jet shaped charge for use in 3⅛-inch OD steel case retrievable guns has been introduced. Under standard test conditions of one-half-inch stand-off, Bull-Jet charge produced a penetration practically seven inches deep, an entrance hole diameter of .45 inches and a Well Flow Index of 1.04. This performance corresponds to salvo shots on the surface under fluid at the same one-half-inch stand-off. (Pan Geo Atlas Corp. Supplements data on Pages 4393-4412, 1960-1961 Composite Catalog.)

For more data, circle E17 on postcard

New Section Mill

The use of this new tool in milling a casing section, preparing for and setting a cement plug will save time by: (1) locating the collars, (2) milling the casing section, (3) jet-washing the section and (4) setting the plug—all in one round trip. (Rotary Oil Tool Company. Supplements data on Pages 4793-4796, 1960-1961 Composite Catalog).

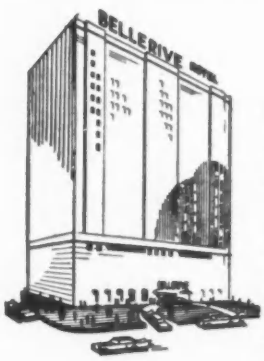
For more data, circle E18 on postcard

New Engine Cut-Off Device

New Schafer Oil and Heat Sentinals are designed to cut off any engine powered by gas or liquid when the oil pressure of the engine drops to a pre-designated low, or the heat generated rises above a set danger point. Sentinels are low in cost, will fit any engine, are dust, water, vibration and corrosion proof and have a long, trouble-free life due to excellent construction, few moving parts and extensive pre-testing. (The Happy Company. Supplements data on Pages 2434-2437, 1960-1961 Composite Catalog.)

For more data, circle E19 on postcard

PREFERRED *in* **KANSAS CITY, MO.**



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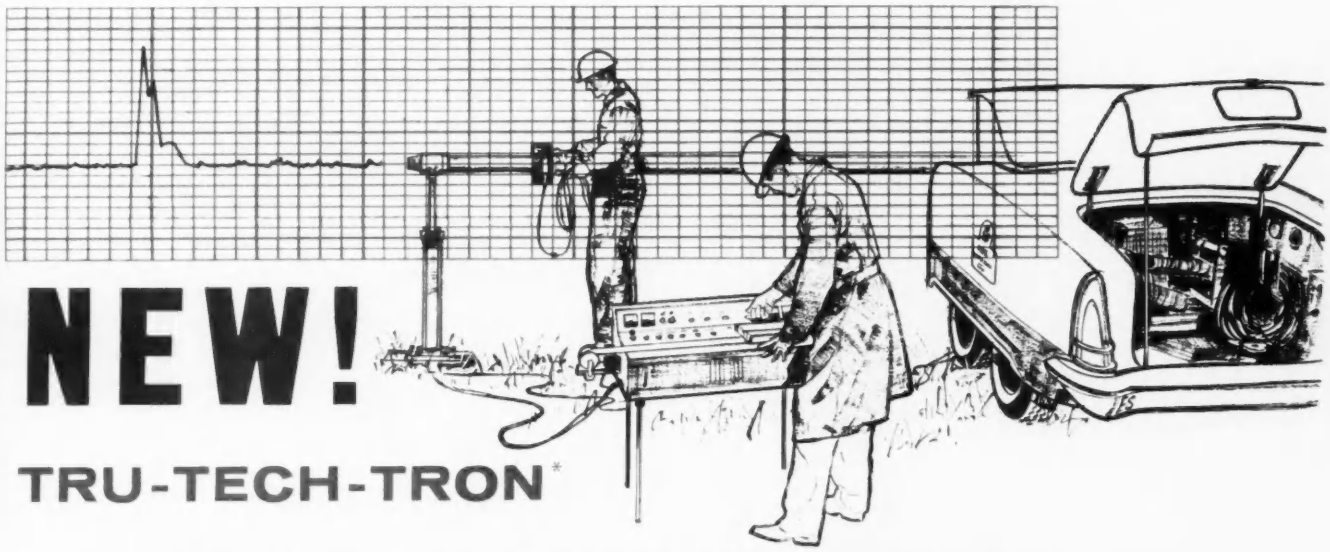


NEW!

TRU-TECH-TRON*

INSPECTION OF USED DRILL PIPE

RECORDS ONLY DEFECTS...NO "NOISE"

Rust, mill scale, and other common pipe surface conditions, have a tendency to create "noise" or "grass" which can be recorded during electromagnetic inspection of drill pipe. If this noise is recorded, it can easily be misinterpreted as harmful defects, or it can obscure the recording of an actual defect.

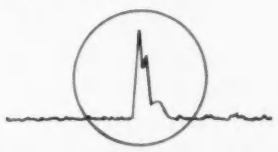
UNISCO's† new TRU-TECH-TRON inspection equipment screens out undesirable noise and produces accurate, easy-to-read defect recordings. When an indication appears on the TRU-TECH-TRON log it represents an *actual* defect. If the pipe is free of defects, *no* indications are recorded.

This superior method of electromagnetic inspection records only the most SEVERE defect at any one point—even when this defect lies in the same diametrical plane with other defects of greater and lesser magnitudes. There is no adding or compounding of defect signals to cause false indications to appear on the TRU-TECH-TRON log.

A self-monitoring feature has been built into TRU-TECH-TRON to assure that each detector is working properly at all times. You learn the true condition of each length of pipe when you use TRU-TECH-TRON. You prevent wasting good material and protect yourself against costly failures.

An 8-page, 2-color brochure which describes TRU-TECH-TRON inspection is available to you now—ask for your copy today or write Department 6 P. O. Box 66669, Houston 6, Texas.

When "noise" or "grass" is not controlled, defect recordings could be overlooked.



TRU-TECH-TRON produces positive recordings of defects — noise is eliminated.

UNIVERSAL INSPECTION & SERVICE COMPANY
A Division of Atlas Bradford Company
3600 Yoakum Blvd. Telephone JA 6-1901 Houston 6, Texas
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UNISCO

*TRU-TECH-TRON is a service mark of Universal Inspection & Service Company.
†UNISCO is a service mark and trade mark of Universal Inspection & Service Company.

Literature

To get your copies, circle key numbers on postcard and mail to WORLD OIL

Pump Specifications

National J-50 triplex plunger pump specifications and features are given in a new six-page bulletin (No. 519) available from National Supply Division of Armco Steel Corporation. Keyed cross-sectional line drawings illustrate construction features of the new 50-horsepower pump for waterflood service, power oil service, salt water disposal and general lease service.

To get a copy, circle E20 on postcard

Frac-Shot

Frac-Shot, a new aluminum pellet propping agent for fracturing oil and gas wells, is described in a brochure by Reynolds Metals Company. Brochure gives pellet specifications, particle concentration and other preliminary Frac-Shot data. Pictures and drawings illustrate what the pellets will do under actual well conditions.

To get a copy, circle E21 on postcard

New 'VeePac' Compressor

Clark Bros Co., one of the Dresser Industries, has released a new six-page Bulletin No. 191 discussing operational and design features of the new Clark Model TVM "VeePac" packaged compressors. Specifications, dimensions and cut-away illustrations are also featured.

To get a copy, circle E22 on postcard

Oil Base Muds Handbook

Useful information on Black Magic and related subjects are presented in a 76-page, pocket-size handbook just released by Oil Base, Inc. Included are mixing formulas, treatment, test procedures, description and additives and instructions for the care and handling of oil base drilling fluids and applications where Black Magic serves best.

To get a copy, circle E23 on postcard

Seamless Buttress Casing

Advantages of casing deep wells with Pittsburgh Steel Company's seamless buttress thread casing are detailed in a new, four-page folder, available from the company. Folder contains a minimum performance properties chart based on three grades of steel and outside diameters of 5½ to 9⅝ inches.

To get a copy, circle E24 on postcard

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a new kind of line pipe for oil-field use

- It resists paraffin build-up with all paraffin-based crudes so far encountered.* And because of its extremely smooth internal surface, friction losses are unusually low.
- It is easily joined by heat fusion . . . ready to operate at full line pressure within a minute. Under normal field conditions, 25 seconds or less are required to heat and make the integral joint.
- It provides lower shipping costs, easier handling, lower installation costs. These advantages are a function of its light weight and ease of joining.

These are the facts. They have been established by more than five years of intensive laboratory testing by Du Pont, and by over two years of field testing in various oil-producing areas of the country, conducted by major oil companies.

Du Pont invites you to examine the **DELRIN** PIPE verifying data in detail. You may obtain complete engineering specifications, plus detailed anaylsis of various field installations, by mailing the coupon. Your request will bring full information on prices and availability, and the location of Du Pont technical representatives serving the oil industry.

**See detailed reports on test installations, available by mailing coupon below.*

Using a simple heat joining tool, this crew is completing the installation of a length of pipe in one of the many installations that have proved the performance of **DELRIN** PIPE in the field over the last two years.

Mail this coupon for information that can help you save money on your next pipe installation...

Polychemicals Department, Du Pont Company
Dept. WO-6, Room 2507P, Nemours Building
Wilmington 98, Delaware

Please send me complete information on **DELRIN** PIPE for oil-field installations.

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Position_____

Firm Name_____

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BAKER WIRE LINE BRIDGE PLUG, PRODUCT 400-N

RELIABLE BRIDGE PLUG

In average wells or tough ones, its dependability is a matter of record.

Here is a bridge plug that commands a lot of respect. The evidence has been piling up for years that this is probably the most dependable bridge plug available anywhere.

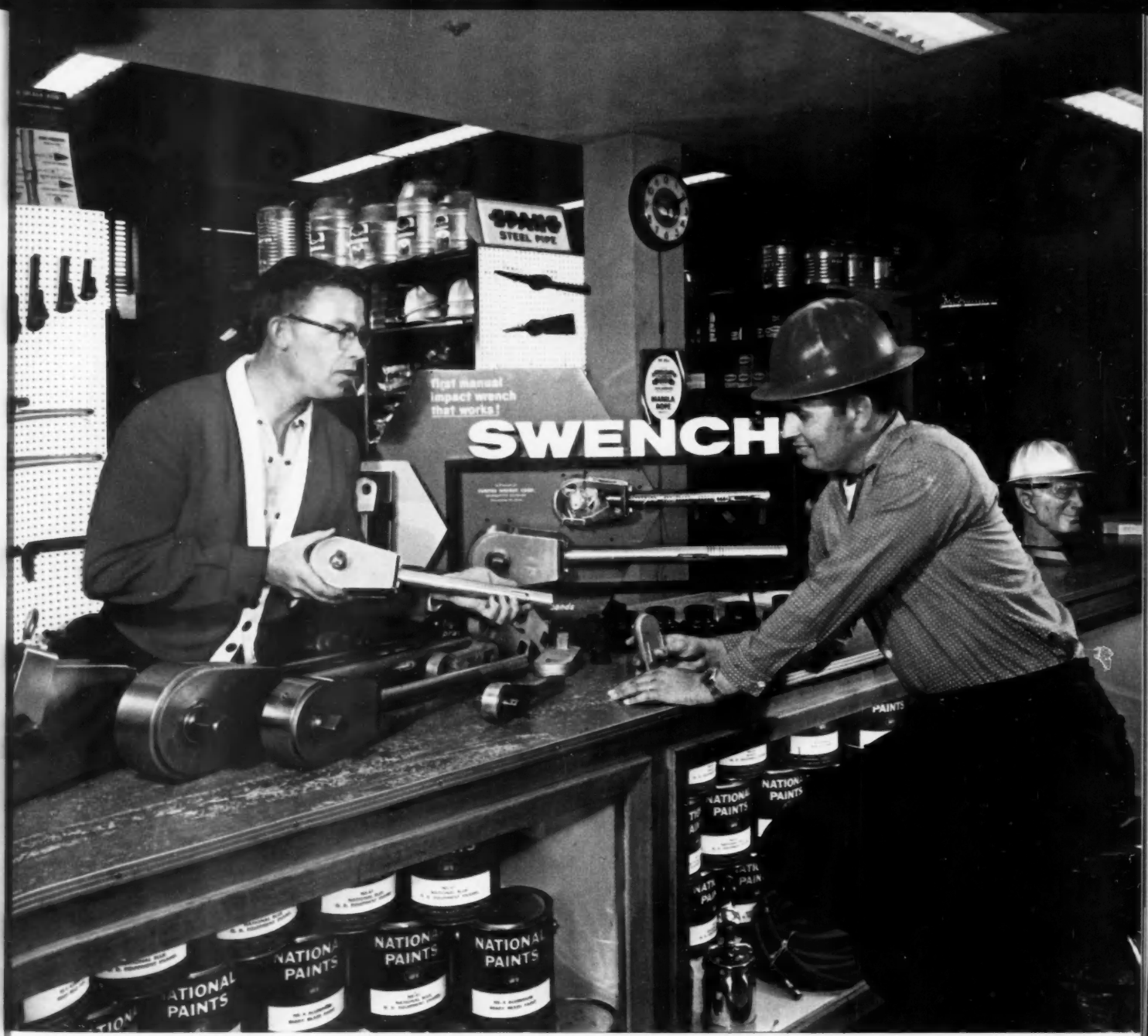
It's got time on its side. Over the years we've refined it into a tool with a tremendous ability to take whatever comes its way downhole.

Whether you measure its life span in hours or in years, a Baker Bridge Plug masters the hydraulic forces in any well—from average wells to the hot, high pressure wells. Reliable is the right word for it.

Leading wire line companies set Baker Wire Line Bridge Plugs accurately and promptly. Other models can be set on tubing or drill pipe. They're made in drillable cast iron for permanent service, and in fast-drilling magnesium for temporary service.

BAKER

BAKER OIL TOOLS, INC. HOUSTON / LOS ANGELES / NEW YORK



Now! Time-saving Swench Wrenches are available through National Supply Stores

NATIONAL NSCO SUPPLY

Unique Swench Wrenches are now distributed through National Supply stores. Swenches are a new concept in manual impact wrench design. Many oil field users have enjoyed considerable savings with these wrenches. They not only reduce costly man hours, but they save valuable equipment from damage resulting from heavy sledging of manual wrenches and cheater bars. Nuts that previously had to be burned off can now be "swenched off" by one man in a matter of minutes. Next time you visit your National Supply Store ask for a quick and convincing demonstration.

This exciting new product is typical of the thousands of products available immediately through the 120 conveniently located National Supply Stores. The products vary widely, but they all have one thing in common. Each is made by an established manufacturer with a proven reputation for quality and reliability.

On next pages: National Supply power slush pumps

POWER SLUSH PUMPS

How National Supply
help reduce

This is a National K-700 power slush pump installed in a preliminary rig-up at Houston, Texas. There is a National pump to meet every horsepower requirement from 80 to 1,250 hp. Investigate the many new features of these pumps.

POWER SLUSH PUMPS
mud system costs

Next time you buy a power slush pump be sure to investigate the many cost saving features of National Supply pumps. You'll find new designs, fast maintenance features, high strength with light weight construction, in a complete range from 80 to 1,250 input horsepower.

Each National pump is designed to meet specific requirements of modern drilling operations. You'll find National pumps give you longer trouble-free service, under more severe conditions, than any comparable pump you can buy.

Here are five of the newest National power slush pumps that incorporate design features needed in modern jet drilling. Features vary with the pump to meet the requirements for which each particular pump is recommended.

K-380 This is a completely new 380 input horsepower slush pump with a new-design fluid end incorporating many features for smoother operation, longer life and easier maintenance. The fluid end is a high strength steel casting with large, direct, smoothly contoured suction passages that minimize resistance to fluid flow. This pump has high structural rigidity, yet is exceptionally light in relation to its 380 input horsepower. A tapered crosshead pin simplifies removal and reassembly of the crosshead, assures perfect alignment. "Fast Change" threaded valve pot cover plates make maintenance easier and encourage frequent inspection of valves and seats. This important feature is found in each of the five pumps described here. Write for Bulletin 520.

K-500 This new 513 input horsepower slush pump provides a high degree of accessibility, which simplifies and speeds up routine maintenance operations. Despite its light weight and compactness, the K-500 is built with typical National durability. The threaded cylinder head and valve pot arrangements permit rapid removal of all related fluid end parts, including the liner, without removing the fluid cylinder head body. Write for Bulletin 500.

K-700 This new National power slush pump is exceptionally light in weight for the 700 input horsepower rating. "Fast Change" threaded valve pot cover plates and cylinder heads are important features. Fluid end is a one-piece steel casting with streamlined internal passages. Cylindrical sections give maximum strength. The fluid end on all National slush pumps is given a thorough hydrostatic test before final assembly. Main frame is fabricated of shaped and formed steel plates, structurals and steel castings, electrically welded into a unit with high structural rigidity. Write for Bulletin 501.

H-850-A National's engineers used a new approach in designing the power end frame for the H-850-A power slush pump. It is a streamlined, super strengthened box-type unit with structural rigidity and durability sufficient to withstand the severest service. Design reduces stresses produced by stroke reversals to the point where they are negligible. Design also incorporates "Fast Change" threaded valve pot cover plates and cylinder heads for fast maintenance. The H-850-A, rated at 850 input horsepower, is built for long pump life with minimum maintenance. Write for Bulletin 497 and supplement.

H-1250 Unique design features of the H-1250 result in reduced cylinder bore wear, longer liner packing service, longer life for connecting rod and main bearings, fast and efficient lubrication. Threaded valve pot cover plates speed inspection of valves and seats. The H-1250 is portable, due to its light weight in relation to its 1250 input horsepower. Get complete details of the H-1250 by writing for Bulletin 502.

All of these pumps, except the K-380, are available with the National Pulsation Dampener. Rig air supply operates the dampener without need for high pressure air supply or any nitrogen supply for pre-charging.

A National Supply representative will be happy to recommend the exact power slush pump to meet your requirements. He will point out the cost-saving features of each of these new pumps. Write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pennsylvania.

Steel

Steel's Symbol of strength, long life, and economy

National fluid end parts are carefully packaged and shipped to assure delivery in factory-perfect condition.

New performance records prove National Super Dual Seal pistons reduce pumping costs . . . add liner life

Performance records prove conclusively that operators can run pumps cheaper with National Super Dual Seal pistons. And, in addition to piston savings, longer liner life can be expected.

Here are some reasons why Super Dual Seal pistons are superior: Exclusive Dual Seal lips provide more effective seal than single lip construction, reduce fluid bypass that results in softening of fabric backing, principal cause of piston failure.

Separate inner and outer cups allow greater flexibility in material selection. Each cup is moulded of rubber compound best suited for its specific function. Pistons are available in both regular and oil resisting compounds.

A void between the two cups serves as a lubricant reservoir that is especially valuable during the priming period. Angle of plate and rubbers is designed to provide adequate room for rubber when piston is installed in the liner.

Forged steel hub will not expand under heavy pressure. Hub is designed to provide interchangeable cup assemblies in A.P.I. 3, 4, 5 or 6 tapers, sizes 6″ through 7¾″.

As a leading pump manufacturer, National Supply has the experience and facilities to produce fluid end parts to meet the most exacting quality standards. In addition to the Super Dual Seal pistons, the following National parts are readily available when and where you need them:

FLUID PISTON ROD PACKING—Fluid pressure actuates the sealing lips. The greater the pressure, the tighter the seal, yet the solid make-up through the body of the packing minimizes danger of overtightening it when it is installed. Rod wear is sharply reduced, because lip pressure is never excessive.

FLUID CYLINDER LINERS—Here are three strong reasons why it pays to use new National Liners. The specified finish and size on the OD assures proper fit with the pump bore. The bore is machined true and concentric with the OD, assuring proper alignment and maximum service life of related parts—piston, rod and rod packing. You get a properly sized and hardened bore in a correctly heat treated forging of known quality to back up the hardened bore.

FLUID CYLINDER LINER PACKING—Resistant to oil, gas heat and chemicals, National Liner Sleeves provide a perfect seal between the liner and pump bore. They are sufficiently hard to be confined in the packing space, preventing excessive flowing and pinching, yet they retain ample resiliency for proper sealing action.

"BLUE STRIPE" AND "BLUE CHROME" PISTON RODS WITH API TAPERS have maximum tensile strength and high resistance to impact. Precision ground and polished to reduce wear of both packing and rod. "Blue Chrome" Piston Rods have a super-hard, abrasion-resistant chrome finish which gives added packing and rod life.

TYPE G-2 FLUID VALVES AND SEATS promote maximum pump efficiency, with maximum effective opening for fluid flow to permit complete filling at high speed. The lower guide, integral with the valve, has a large contact area which reduces wear and minimizes possibility of cocking. A heavy clamp plate and lock gives longer valve service life.

Specify National Fluid End Parts next time you buy. Ask your representative, or write direct to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

ARMCO National Supply Division

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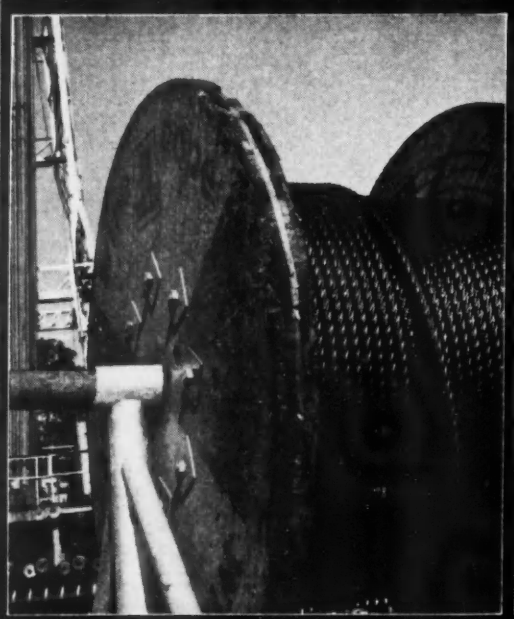
SUPPLY

Facts For Drillers



rsDetermined To Cut Costs

If you want reason-why facts about equipment that really does cut costs, let's get together!

J&L drill pipe and wire rope, McDowell "Fast-Line" couplings on light wall steel pipe, Gardner-Denver mud pumps—why be satisfied with hearsay about this and other equipment from J&L when you can have performance facts!

Call your J&L Supply man—or write us at Tulsa, Room 121, Drawer 2481.

Jones & Laughlin Supply Division—Tulsa

121

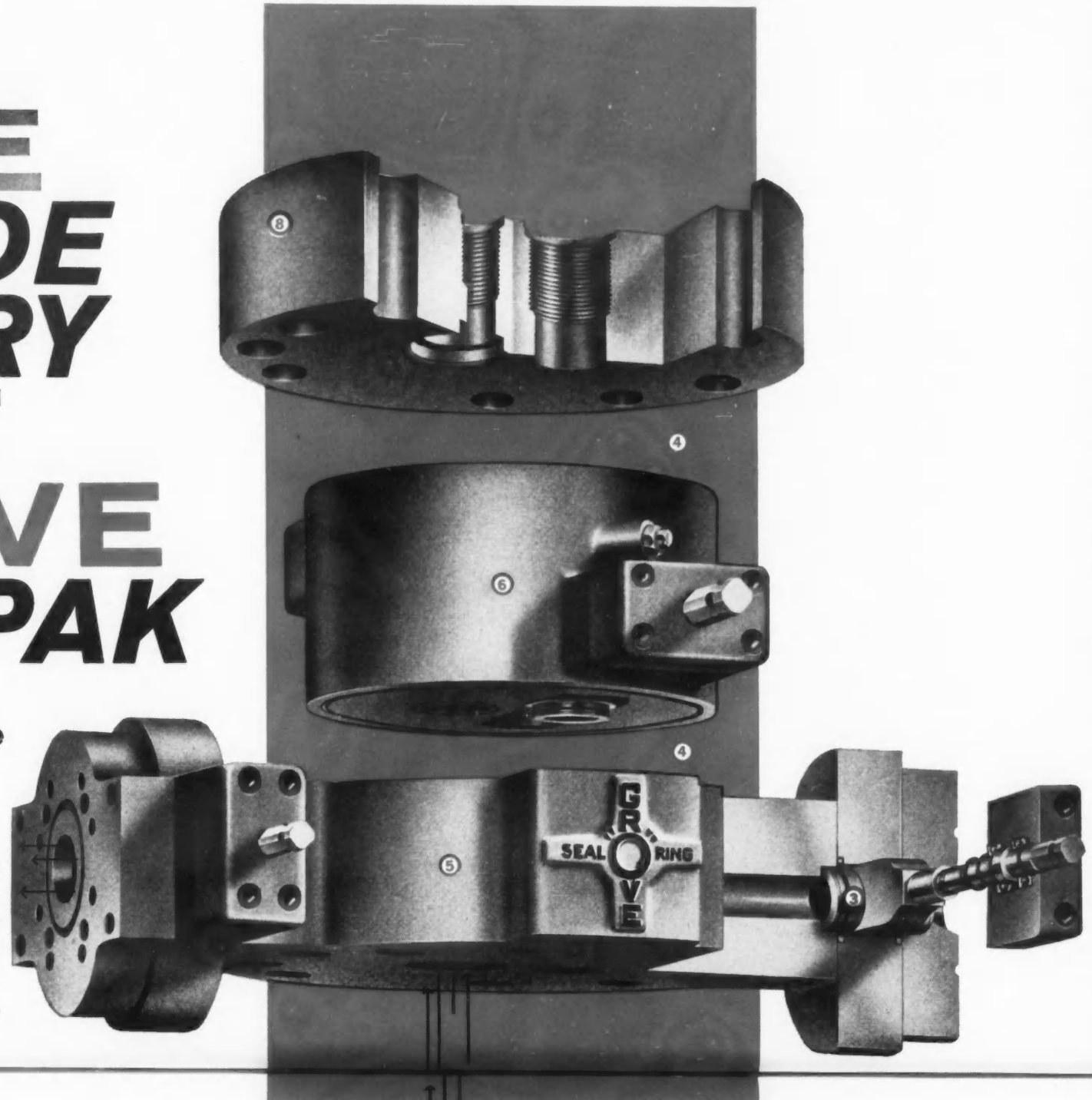
For more data on advertised products, use Readers' Service Cards, last page.

THE INSIDE STORY OF GROVE VALV-PAK

Compact • Versatile

Trouble-Free

Grove Seal-"O"-Ring® Valv-Pak combines the compactness and light weight of an integral Christmas Tree valve assembly with the flexibility of a conventional wellhead manifold that permits any single component to be changed without replacing the complete unit.



complete unit.

CHECK THESE GROVE VALV-PAK FEATURES:

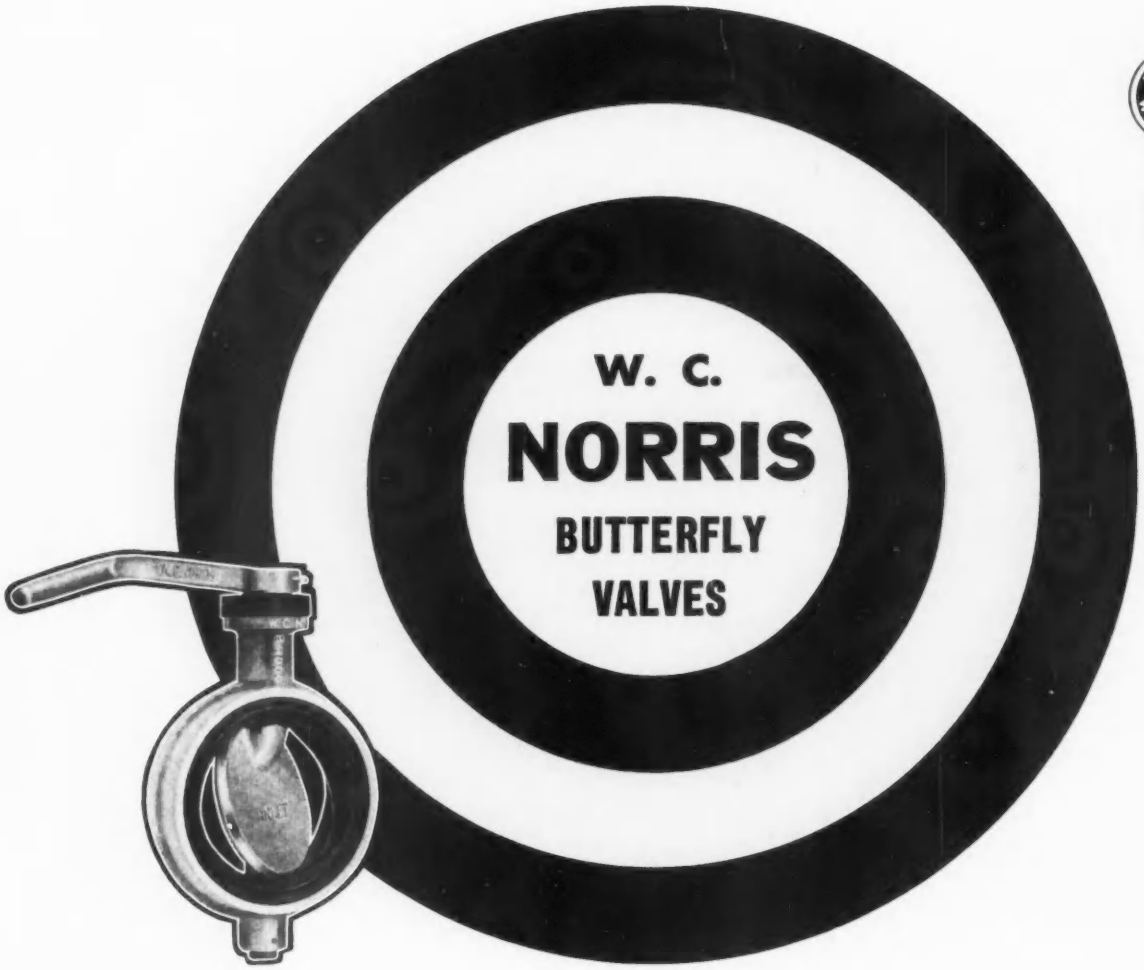
1. Patented Grove Seal-"O"-Ring design for double-action seal. Metal inner seat rings give primary metal-to-metal seal backed up by O-Rings.
2. Precision-finished stems with lifetime lubricated ball bearings.
3. No lubricants or sealing compounds needed. Squeegee action of O-Rings against gate assures a clean polished surface for bubble-tight metal-to-metal seal.
4. Adaptable to meet any need. Unique Grove Valv-Pak construction gives ultimate flexibility. Valv-Pak can be factory tailored to your precise needs. Parts damaged by erosion or corrosion may be replaced in the field faster and more economically than with conventional designs.
5. Wing valve cross can be furnished in full opening or reduced port design.
6. Swabbing valve (optional).
7. Through conduit, full opening design for ideal flow characteristics and for accommodating down-hole tools.
8. Top and bottom flanges may be supplied to accommodate any wellhead fabricator's specification.
9. Studs furnished for all flanged outlets.

For more data on advertised products, use Readers' Service Cards, last page.

GROVE PRODUCTION VALVES

GROVE VALVE AND REGULATOR COMPANY
A Subsidiary of Walworth

6529 HOLLIS STREET • OAKLAND 8, CALIFORNIA
Offices throughout the United States and in Western Canada



Target Versatility - Economy

Now you can reduce costs and simplify valve specifying by using the highly versatile and economical Norriseal Wafer Type Butterfly Valve. Designed for working pressures to 150 psi, the Norriseal Valve features removable and interchangeable rubber and metal seats . . . takes up less line space . . . can be easily and quickly removed for "on-the-spot" maintenance . . . is field repairable. The wide selection of trim available qualifies the Norriseal Valve for use in many oil field and industrial applications.

Write for prices and complete literature today!

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Butterfly Valves

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'Round the clock operations call for a sure source of supply for original and replacement parts such as pipe, valves and fittings.

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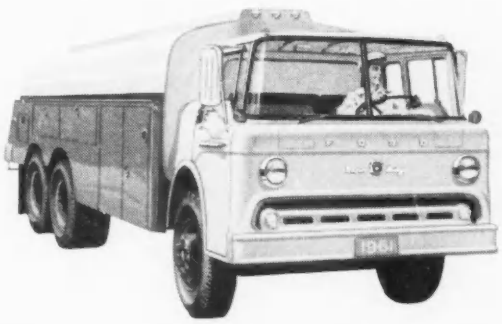
FORD DIVISION, *Ford Motor Company*

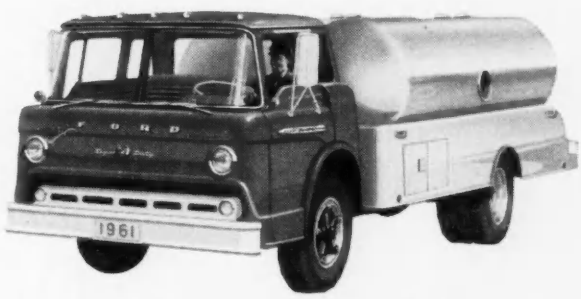
- **New Super Duty V-8 Dealer Warranty—100,000 miles or 24 months!**
- **New extended Dealer Warranty for entire truck line—12 months or 12,000 miles!**
- **New stronger frames and huskier cabs for Conventional Cab models!**
- **Now 222 money-saving Tilts, Tandems and Conventionals with Super Duty V-8's to choose from!**

Ford's rigid quality control program gives you unsurpassed dependability! Positive evidence of uniformly high production and inspection standards is the exclusive new 100,000-mile engine warranty. On 401-, 477- and 534-cu. in. Super Duty V-8 engines, each major engine part (including block, heads, crankshaft, valves, pistons, rings), when engine is used in normal service, is warranted by your dealer against defects in material or workmanship for 100,000 miles or 24 months, whichever comes first. Warranty covers the full cost of replacement parts . . . full labor costs for the first year or 50,000 miles, sliding percentage scale thereafter.

In addition, an extended warranty covers all 1961 Ford Trucks of any size. Each part, except tires and tubes, is now warranted by your dealer against defects in material or workmanship for 12 months or 12,000 miles, whichever comes first. The warranty does not apply, of course, to normal maintenance service or to the replacement as normal maintenance of such items as filters, spark plugs and ignition points. No other truck gives you such protection for your investment; never before could you be so confident of long-range durability!

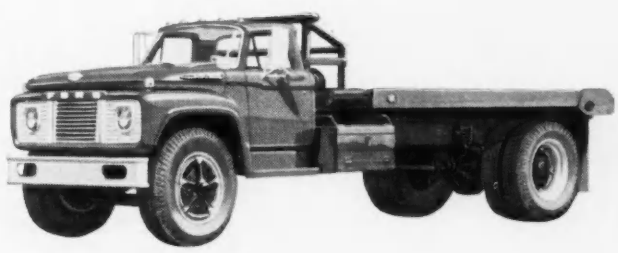


Tandem Axle models are available with tilt cabs. As with conventional tandems, aluminum walking beams, wheels, fuel tanks are offered to cut weight.



Most popular Tilt Cabs on the American road! 1961 models represent five years of improvements. Four series—up to 36,000-lb. GVW, 65,000-lb. GCW.

New tougher tandems offer greater strength in chassis, cab and sheet metal . . . new wide-track front end stability. Powered by rugged Super Duty V-8's, Ford tandems go up to 51,000-lb. GVW, 75,000-lb. GCW.



New huskier conventional trucks feature lighter, stronger frames of high-tensile steel . . . heavier gauge metal and stress-isolating independent mounting for radiator, fenders and cab.

QUALITY-BUILT... MAINTENANCE-ENGINEERED

FORD TRUCKS COST LESS

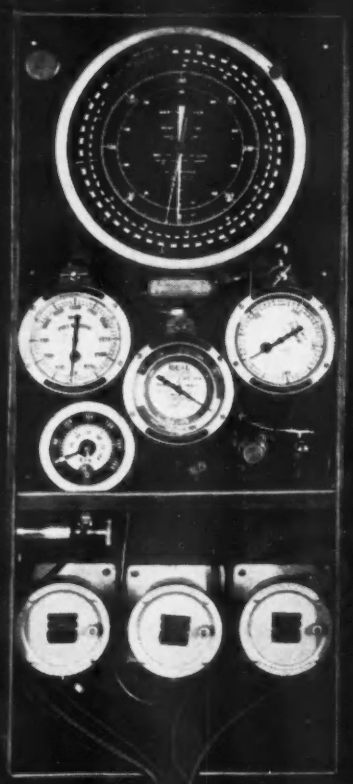
For more data on advertised products, use Readers' Service Cards, last page.

DRILLING CONTROL

INDICATING

Type "D" **WEIGHT INDICATOR**

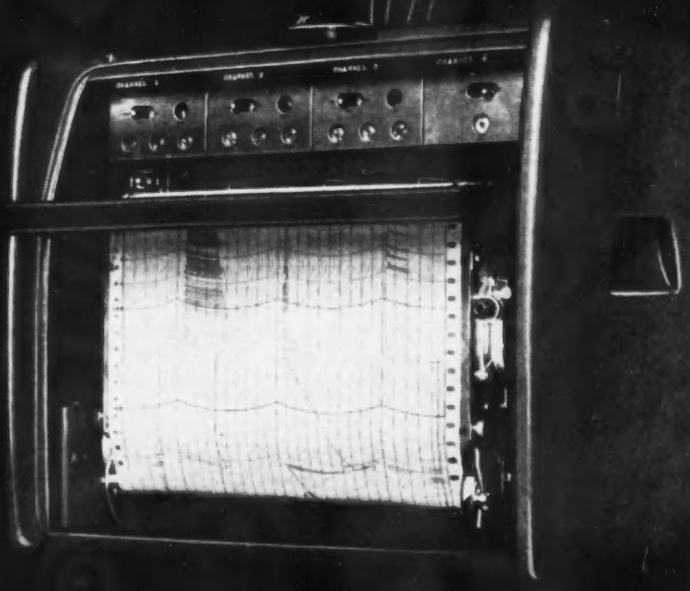
Pump Pressure Gauge
Rotary Torque
Tong Torque
Rotary Speed
Pump Speed



RECORDING

the **"DRILLOGER"**

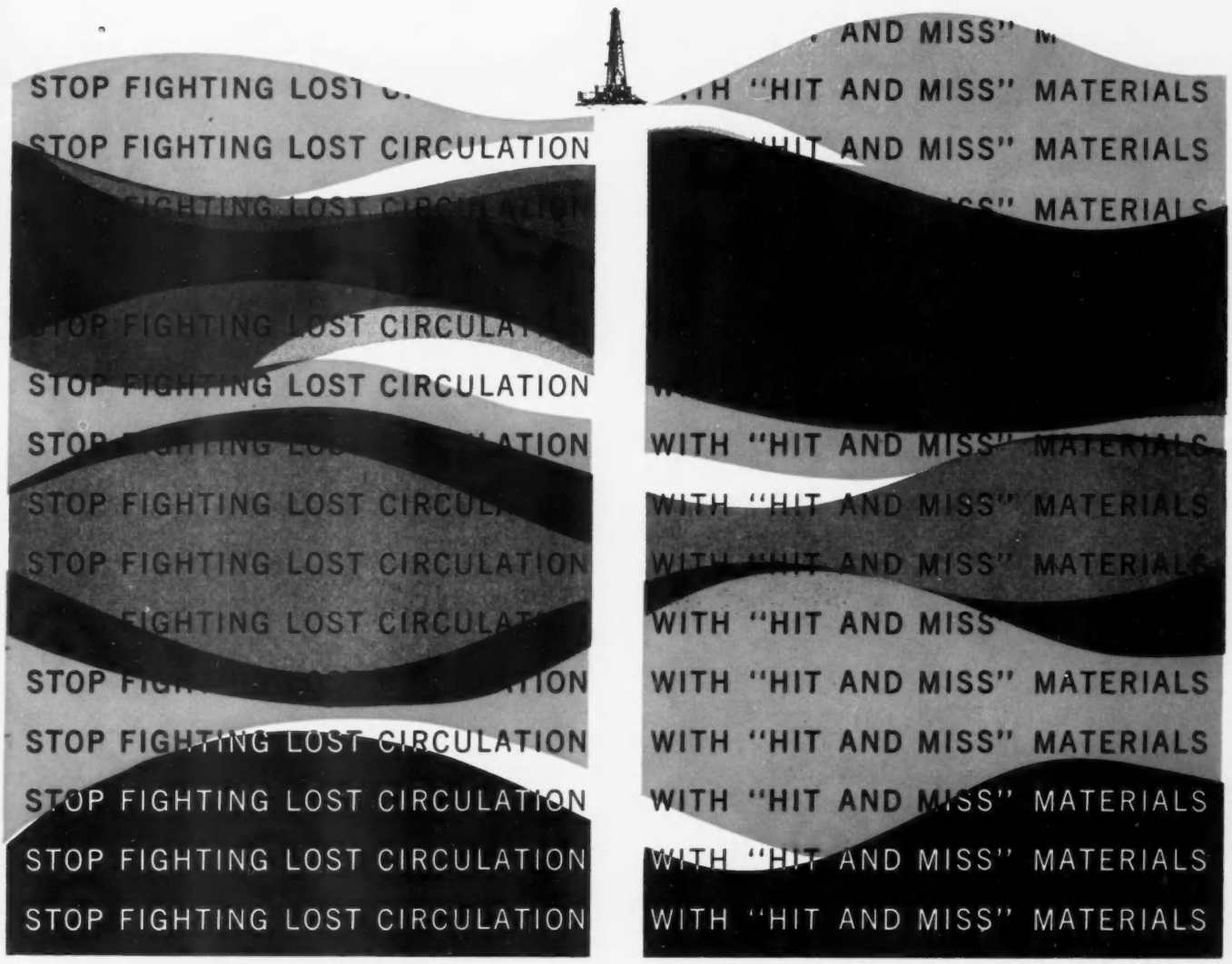
Weight
Pressure
Torque
RPM
SPM
Penetration Rate



MARTIN DECKER

Write for descriptive literature
MARTIN-DECKER CORPORATION, DEPT. P-90
3431 CHERRY AVENUE, LONG BEACH 7, CALIF.

World's principal manufacturer of Oil Well Drilling Instrumentation



10 years of research and testing have perfected a quick, positive sealer!

Cert-n-Ceal®

(A PRODUCT LICENSED FOR SALE BY MACCO, CORPORATION, PARAMOUNT, CALIFORNIA.)

A patented product, Cert-N-Ceal is the first Lost Circulation material scientifically formulated to provide:

- **instant mechanical action**
- **powerful, delayed swelling qualities**
- **sealing capabilities that strengthen with pressure**

A strong granular substance, it is hydraulically non-compressible under fluid pressures up to 10,000 psi. Cert-N-Ceal is entirely inorganic, contains no high pH materials, and will not ferment or decay. Having a dry density of nearly 70 lbs./cu. ft., it is easily mixed — in minutes — in all muds and cements. Using 30 lbs./bbl. or more, Cert-N-Ceal can be added through hoppers or compounded in suction pits with guns. It is packaged in 50 lb. multi-wall bags for convenient, safe handling.

Next time — let Cert-N-Ceal solve your Lost Circulation problem. Eliminate costly mechanical difficulties.

see Cert-n-Ceal in action!

Write or phone for a free motion picture product demonstration.

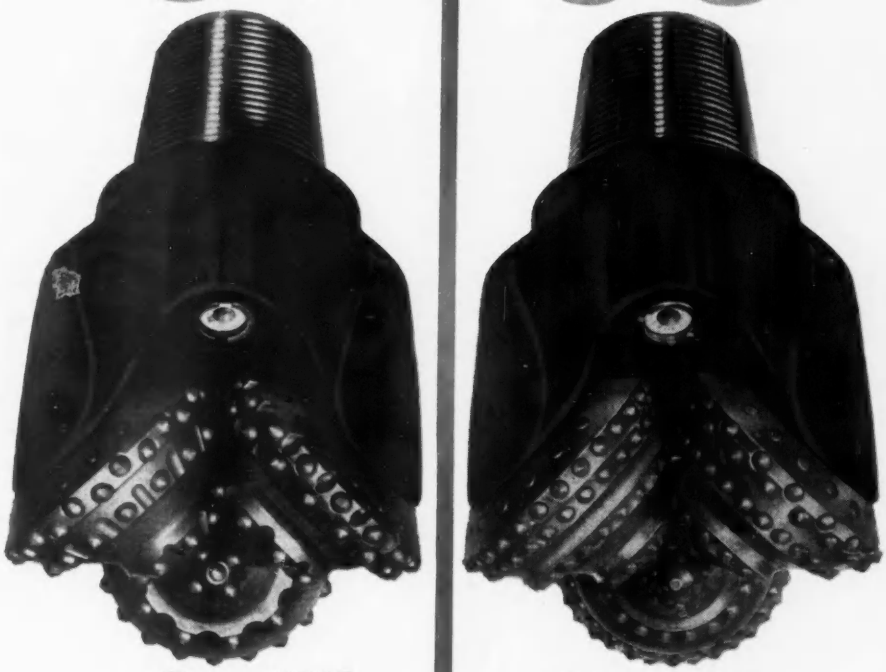
distributed internationally by the KEN corporation

This machine bites clean.

The strength of any tubing joint depends a lot on how tight the joint makes up. The joint must have perfect threads. That's why National Tube has installed this special carbide threading machine to thread oil country tubing (2" to 4½" O.D.). The high-speed carbide tools cut threads that are the cleanest, strongest, most accurate ever produced. So, naturally they make a tighter connection.

National Tube uses two other carbide-tooled machines in this threading line—a profiler that

C-7 | C-8
C-7 | C-8
C-7 | C-8
C-7 | C-8



C-7 | C-8
C-7 | C-8
C-7 | C-8

SETTING NEW RECORDS

in drilling hard abrasive formations

- Conical shaped tungsten carbide inserts insure FASTER PENETRATION
- Flush tungsten carbide inserts insure FULL GAGE HOLE
- Threaded flow nozzles for easy installation
- Available for both fluid and air circulation

Smith TOOL CO.

A Division of SMITH INDUSTRIES International, Inc.

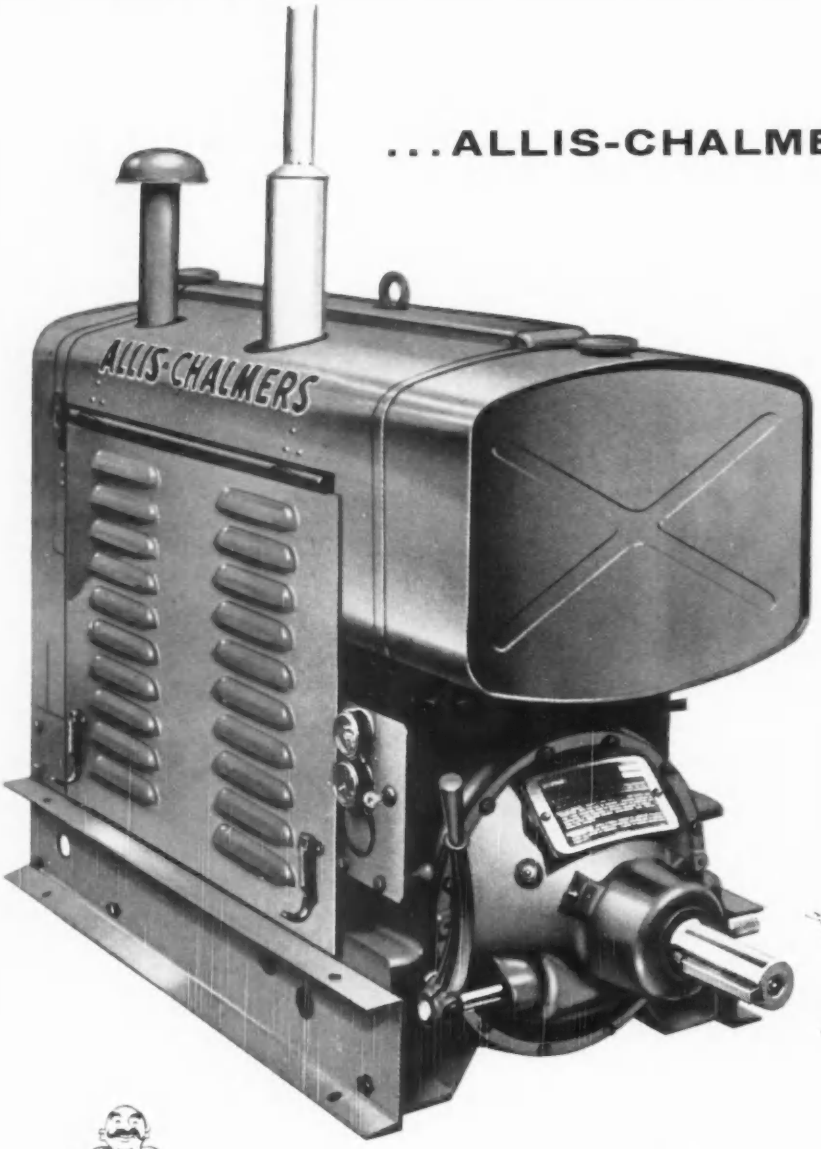
COMPTON, CALIFORNIA

Branches in Principal Oil Centers Throughout the World

OUR 25th YEAR

big power at low operating cost

...ALLIS-CHALMERS PEP* ENGINES



Rugged

Rugged because they are designed to take the year-after-year, sudden-overload, all-weather punishment of tough tractor service.

Thrifty

Thrifty because every bit of fuel goes to *work*. The POWER-CRATER engine burns the fuel completely . . . does not send wasted horsepower up the exhaust stack.

Compact

Compact and easily portable, these power units are mounted on their own base ready to install anywhere in a jiffy.

Powerful

Powerful. You have a choice of horsepowers from 17 to 67, but that's just half the story. These engines deliver high torque at normal working speeds.

Simple to Maintain

Simple to maintain . . . with such advantages as removable wet-type cylinder liners and parts and service right nearby.

Ask your Allis-Chalmers dealer to show you how to put new PEP in your powered equipment. Allis-Chalmers, Milwaukee 1, Wisconsin.

*Packages of Economical Power			
	G-138	G-149	G-226
Displacement, Cu In	138	149	226
Horsepower (gasoline)	38.8 @ 1800 rpm	45 @ 2000 rpm	67 @ 1800 rpm
Fuels: Gasoline, kerosene, distillate, and natural gas, plus LPG for the G-149 and G-226. Also diesel engines—in various models up to 516 hp.			

POWER-CRATER is an Allis-Chalmers trademark. BE-25

ALLIS-CHALMERS

***POWER* FOR A GROWING WORLD**

DISTRIBUTOR SALES OFFICES AND MAGAZINES:

Dixie Dynamite Distributors, Inc.
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Lafayette, Louisiana
Hattiesburg, Mississippi
Houma, Louisiana

Southwestern Pipe, Inc.
Alice, Texas
Brookhaven, Mississippi
Houma, Louisiana
Lafayette, Louisiana
Lake Charles, Louisiana
Shreveport, Louisiana

Beeville H. & T. Sales Company
Beeville, Texas

Southwestern Explosives and Supply, Inc.
Midland, Texas

Deupree Distributing Company
Oklahoma City, Oklahoma
Tulsa, Oklahoma
Albuquerque, New Mexico

Milne Explosives Company
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John Day, Oregon
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THE CYANAMID SEISMOGRAPH LINE*:

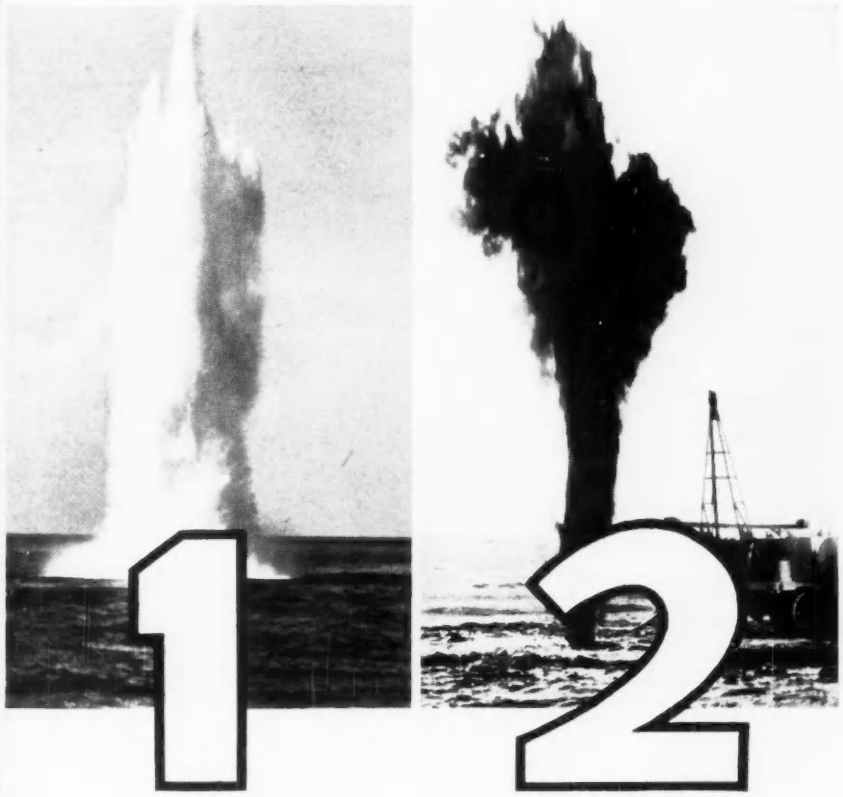
Dynamites
Hi-Speed
Geogel®
Ajax® S

Blasting Agents
Cyamon® OS
Cyamon® S
Cyamon® S Primer

40% Pattern Powder

for Safe, Dependable Seismic Prospecting, Specify

CYANAMID BLASTING AGENTS!



if by sea! **if by land . . .**

CYAMON® S nitro-carbo-nitrate blasting agent and CYAMON® S PRIMER, designed for use on land, are the newest additions to Cyanamid's seismograph line. They are packed in 2″ x 1 lb. and 2½″ x 1 lb. metal containers to withstand moderate to high degrees of water pressure.

CYAMON S cans are *red;* PRIMER cans are *blue* and have a recessed well for blasting cap insertion. Threaded connections make it easy to couple cans for desired column charge.

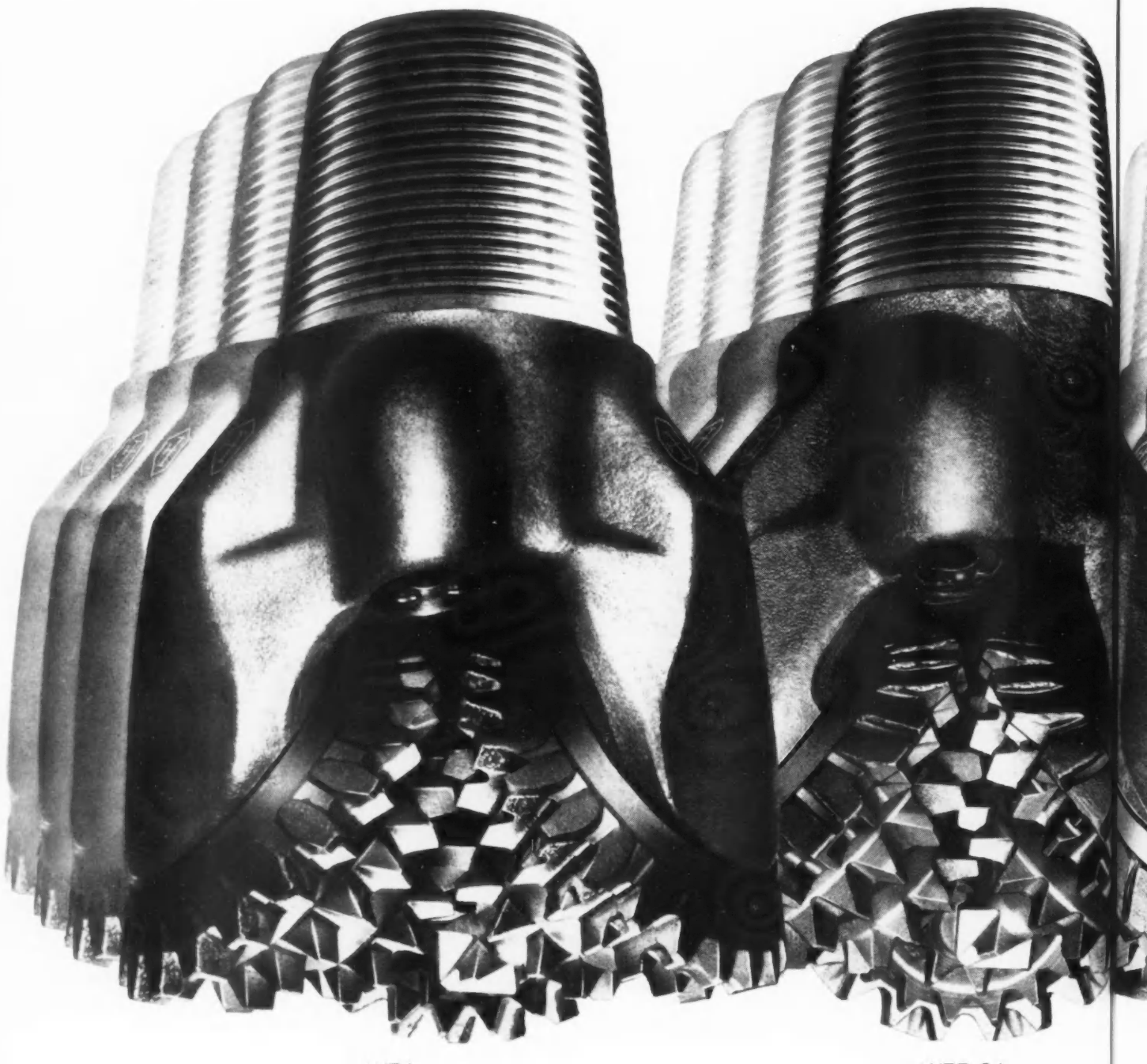
CYAMON® OS specifically developed for off-shore use, complies with U. S. Coast Guard regulations. It is packaged in metal containers of 4½″ x 10 lb., 4½″ x 16⅔ lb., 5½″ x 25 lb., 8″ x 40 lb., and 8″ x 50 lb. Not cap sensitive, it requires a primer for detonation.

Cyanamid also offers Hi Speed, Geogel® and Ajax® S seismograph dynamites and 40% pattern powder. For complete information, contact your nearest Cyanamid distributor.

CYANAMID

AMERICAN CYANAMID COMPANY
EXPLOSIVES AND MINING CHEMICALS DEPARTMENT
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.



W7J W7R-2J

We don't change the name...we changth

Year-after-year the names of Hughes bits remain the same . . . but not their performance. This is being improved, constantly. Regardless of how well a bit performs, our engineers are never satisfied. They are continually challenged by new facts from the field and from research to find new ways to increase penetration rate . . . or footage . . . or both.

1961, Hughes Tool Company

W7R-J

...gthe performance

Today's Hughes bits come to you under the same series names they have for years... but there's a whale of a difference between the performance of the old and new bits. That's why you get the most hole per bit today with Hughes bits. And why you'll get more tomorrow. To keep your hole costs down — go all the way with HUGHES.

Specific new improvements in the **Hughes W7 Series**

4 recent changes have lengthened life of W7 Series bits, made it possible to use heavier weights, and increased penetration rate

Change No. 1 has materially increased bearing life through the improvement of metallurgy of rollers and roller bearing surfaces.

Change No. 2 has increased resistance of heel row teeth to gage wear through use of webs connecting heel row teeth.

Where gage wear **is not** a serious factor, the "L" shaped gage on the W7 helps these bits deliver more footage and faster penetration rate. For areas where highly abrasive formations are encountered, two or more teeth are joined by webs to provide increased gage facing and greater resistance to gage wear. In the W7R-2, webs join the heel teeth in pairs. The W7R has three or more teeth joined by webs.

Change No. 3 has permitted use of increased weight on bit, and equalized wear on all three cones. This has been accomplished by redesigning the cutting structure and cone shell.

Change No. 4 has extended cutting life of bit in areas where nose bearing wear is serious. This has been done through the use of improved integral pilot pin bearing.

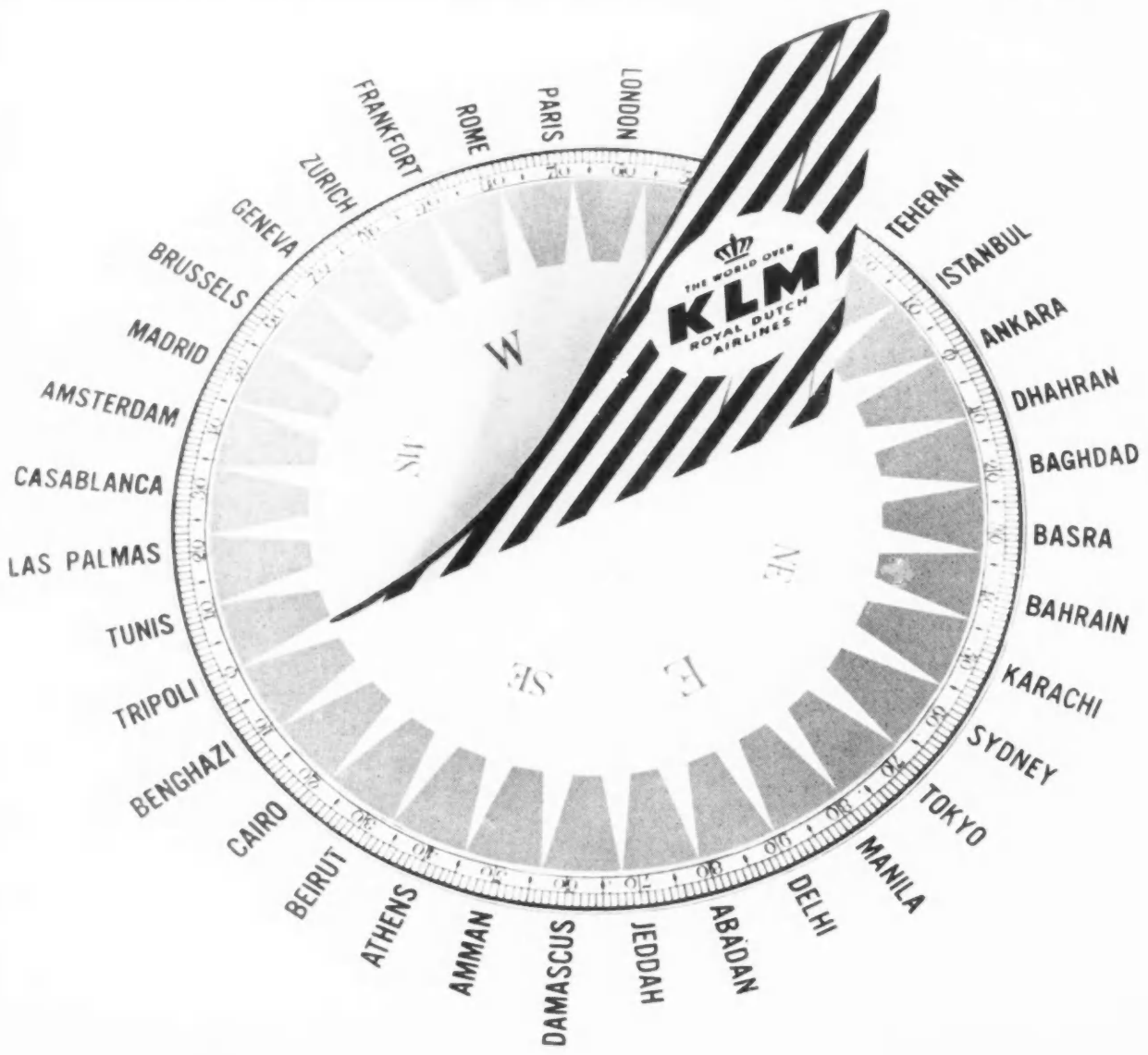
In hard and hard abrasive formations, drillable with milled-cutter bits, operators prefer Hughes W7 series bits for their low cost performance.

HUGHES

ORIGINATOR AND WORLD'S LEADING DEVELOPER OF CONE-TYPE ROCK BITS

"THE OILMAN'S AIRLINE" TO ALL THE WORLD

• Pick a point on the compass and you'll see that KLM provides regular services to every major active oil center • Flights from New York, Houston, Montreal, Miami • A Petroleum Industry Service Department for consultation on your specialized problems • Experienced cargo personnel help you prevent costly critical shutdowns • A 41-year tradition of personalized service to passengers • For passenger service: call your travel agent or KLM office. For cargo service: call your cargo agent, freight forwarder or KLM office. KLM, 609 Fifth Avenue, New York 17, New York. IT'S A TREAT TO GO DUTCH!



ACIDIZE WITHOUT DAMAGING CORROSION

with Halliburton's new MULTIPLE SERVICE ACID MSA

MSA is Halliburton's new acidizing medium combining acetic acids with inhibitors and surfactants. This new acid makes possible effective treatments in situations where regular HC1 acid cannot be used due to temperatures or other well conditions which could cause damaging corrosion on tubing, casing, or pump parts.

MSA *for hot wells*

The slow reaction rate of MSA on limestone permits treatments of wells with bottom hole temperatures exceeding 250°F. Contact with down-hole equipment in excess of 24 hours can be allowed without corrosion damage.

MSA *as a perforating fluid*

A relatively small quantity of MSA can be used as the cement displacement fluid to bump the cementing plug and be left in the hole to help avoid perforation damage. Considerable rig time can often he saved with MSA since it is unnecessary to bump the plug with water or mud, swab, run a slug of HC1, perforate, and swab again. MSA can be used as a breakdown fluid to spearhead a fracturing treatment, if the fluid in the casing behind the MSA is compatible.

MSA *for removing scale*

A pump scaled with calcium carbonate can be treated *in the hole* with MSA to remove the scale. Even for extended periods, MSA exhibits little effect on chrome plated parts or stainless steel, and no damaging effect on aluminum, permitting this long contact without damaging the pump or the tubing.

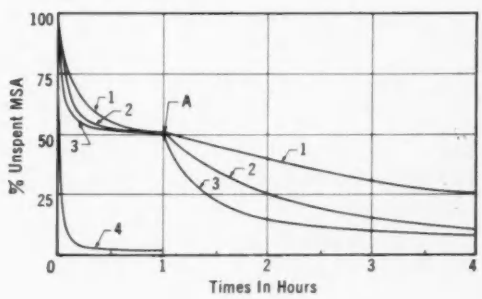
MSA *for leading conventional HCl treatments*

A slug of MSA spotted ahead of a regular HC1 treatment will help improve results due to the retarding action of MSA which keeps live acid at the leading edge of the treatment for longer periods than faster reacting HC1.

These are but a few examples of the many new applications being made possible by MSA. Check with your Halliburton man for the latest details — and the full story on how MSA may increase stimulation results for your wells.

Two samples of P-105 steel subjected to a 72 hour acid exposure test at 250° F. (left) in MSA and (right) in HC1 acid. Note the excessive pitting caused by HC1 with the effect of MSA on the other sample barely noticeable.

REACTION TIMES ON LIMESTONE
MSA vs HCl



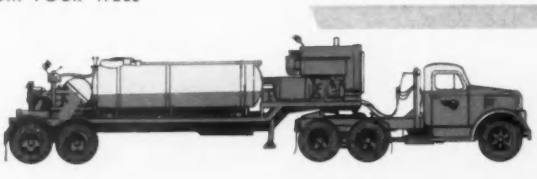
A. Pressure released from 1000 P. S. I. to atmospheric pressure.

8.4 CM²/MI (Equivalent to 0.1 inch fracture)

1. 80° F.
2. 160° F.
3. 240° F.
4. 15% HCl @ 1000 P. S. I., 80° F.

275 SERVICE CENTERS . . .
JUST MINUTES AWAY FROM YOUR WELL

CHEMICAL SERVICES



Halliburton
COMPANY . DUNCAN, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

Economy starts

with the right combination of

TWENTY GRAND

boats...

* LARGEST FLEET OFFSHORE

From the largest fleet of crew and supply vessels offshore select the one most economical combination for your particular operation. Whether you need service for one or for a dozen rigs, TWENTY GRAND'S modern fleet holds the best solution to any supply problem. Let this versatile fleet serve you.

Supply vessels from 350 to 650-ton capacity. Combination crew/stand-by boats from 65 to 95-footers. High-speed crew boats.

TWENTY GRAND towing INCORPORATED

OFFSHORE OIL CENTER, MORGAN CITY, LOUISIANA
Phone: Morgan City 459-5013, New Orleans 523-4781

For more data on advertised products, use Readers' Service Cards, last page.

TIW

THE BEST CEMENT JOB WITH THE LONGEST LINERS

TYPE **LP** LINER SETTING ASSEMBLY

Time-Tested Equipment in Experienced Hands...

TIW... pioneer developer of liner setting equipment . . . provides time-tested experience in successfully cementing the longest liner string your well requires.

T-I-W trained field engineers supervise the running of your liner . . . with dependable T-I-W Liner Setting Equipment . . . and will supervise cementing operations, when desired, to assure maximum efficiency.

The T-I-W Type LP Liner Setting Assembly is recommended for setting long liners, where wiping the strings clean of cement is desired.

The assembly, shown at right, consists of a Type LS Set Shoe (with or without back pressure valves), a Landing Collar which provides a seat for the Wiper Plug, a Liner Hanger (when it is desired to suspend the liner), a Type L Packer with or without Hold-Down Slips (a Liner Setting Collar can be furnished when packer is not desired), a Liner Wiper Plug pinned to the Inverted Swab Assembly, a Type L Setting Tool with setting string connection, a cementing Manifold with setting string connection to retain the Pump Down Plug, and a Pump Down Plug to wipe the setting string.

CALL, WRITE or WIRE TODAY for complete details on dependable T-I-W Liner Setting Equipment and experienced field supervisory service.

The Hanger With Most Positive Performance

TEXAS IRON WORKS

Manufacturers of: T.I.W. Portable Rigs . . . T.I.W. Safety Joints . . . T.I.W. Rotary and Casing Slips . . . T.I.W. Grief Stem Safety Valves . . . T.I.W. Packers for every purpose . . . T.I.W. Pump Chambers . . . T.I.W. Mudmixers . . . and many other oil field tools.

GENERAL OFFICE and MAIN PLANT: 1401-1423 Maury Street, P O. Box 16068, Houston 22, Texas
Other Shops at Victoria and Corpus Christi
EXPORT REPRESENTATIVE: Val R. Wittich, 30 Rockefeller Plaza, New York, N.Y.
IN VENEZUELA: Oilfield Sales & Service, S. A., Anaco & Maracaibo
IN CANADA: Garrett Oil Tools, Ltd., Edmonton, Alberta

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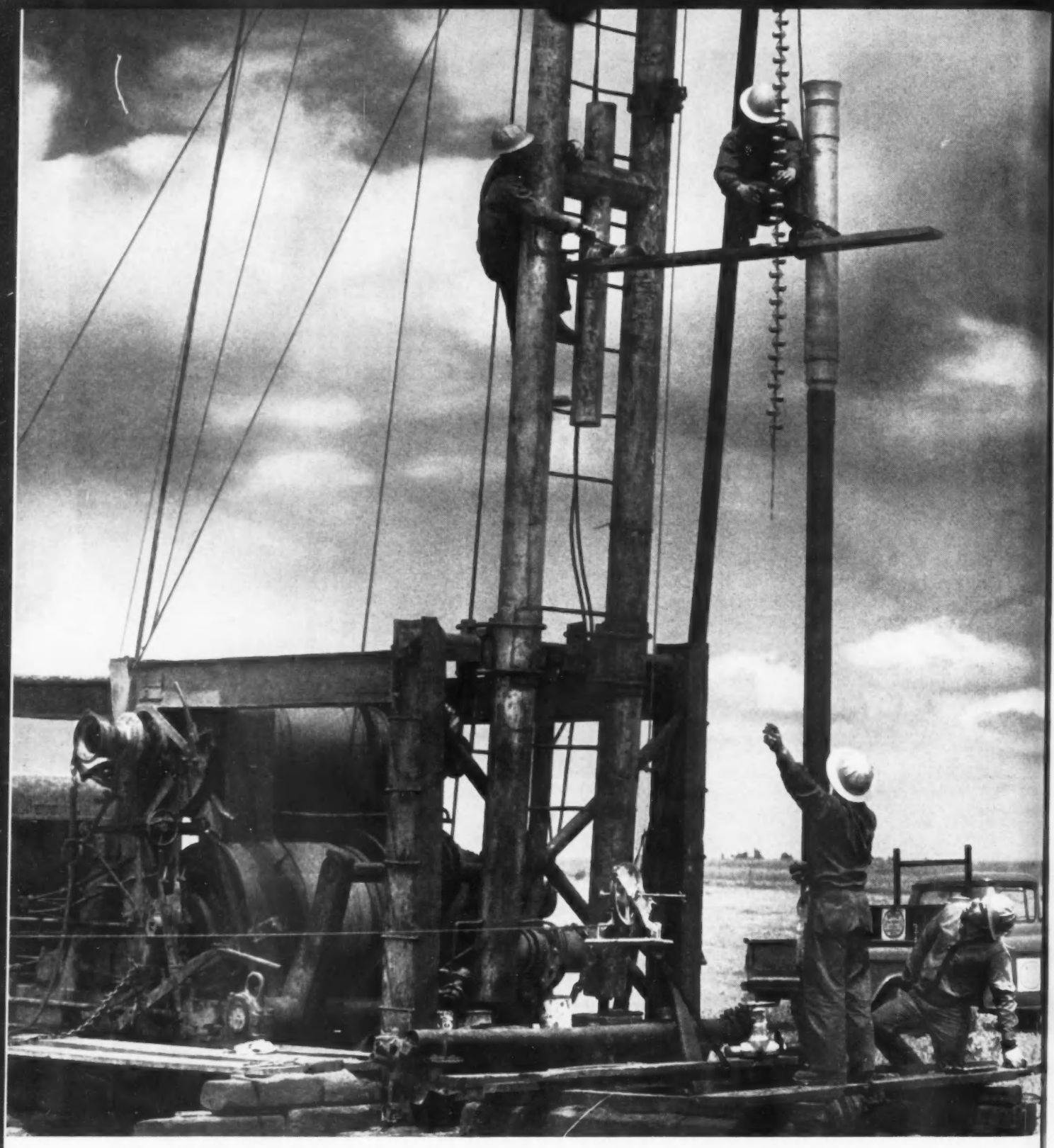


Servicing the Herron No. 1. This servicing unit, owned by McKaig Well Servicing Company, Crescent, Okla., was photographed as preparations were being made to reperforate the hole at the Herron No. 1, located near Hunter, Okla. The unit was rigged with 7,000 ft of Bethlehem 9/16-in. 6 x 7 sand line with plastic core, and 8,000 ft of Bethlehem 3/4-in. 6 x 19 drilling line with fiber core. Bethlehem Wire Rope, because of its ruggedness and ease of handling, is ideal rope for servicing units.

There's a distributor of Bethlehem Rope near you, supplied by our nationwide network of wire rope mill depots.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

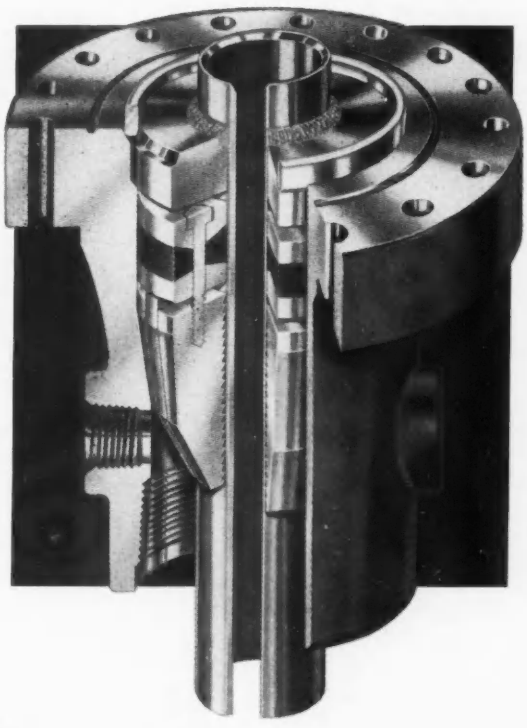
Steel

for Strength
... Economy
... Versatility

BETHLEHEM WIRE ROPE
BETHLEHEM STEEL

Rector M-4

A low-cost casing head designed for positive trouble-free completions



The Rector Type M-4 casing head is a simple and compact head, designed especially for the safe, economical completion of any medium pressure range well.

The Rector M-4 seals permanently, without the use of resilient packing. It carries a restricted ring groove for final setting which upgrades the working pressure of the flange connection to the next higher rating, permitting connection of the next higher pressure rated tubing head without the use of cross-over flanges.

The Rector M-4 flange has a standard A.P.I. ring groove for attachment of drilling control equipment and is furnished with a removable drilling protector ring.

For economy and dependability choose a RECTOR M-4 casing head for your next completion. Available through your favorite supply store or your RECTOR representative.

30 YEARS MAKING THE OIL INDUSTRY SAFER

Rector

WELL EQUIPMENT CO., INC.

Making the Oil Industry Safer!

1100 North Commerce, Fort Worth, Texas
Houston Plant: 2215 Commerce Street

PESA PARTNERS IN PETROLEUM PROGRESS

MONOGRAMMED EQUIPMENT CERTIFICATE NO. 2158

EXPORT REPRESENTATIVES: CONTINENTAL-EMSCO CO., MID-CONTINENT SUPPLY CO., OILWELL DIVISION OF UNITED STATES STEEL CORPORATION

FORCE YOUR DRILLING COSTS DOWN

WITH MILWHITE PRODUCTS AND MUD TECHNOLOGY

MILWHITE

MILWHITE MUD SALES COMPANY

HOUSTON, TEXAS

DIVISION OF MISSISSIPPI RIVER FUEL CORPORATION

873,000

Johnston Testers' packers have worked successfully in 873,000 drill stem tests over a period of 35 years. In two tests below 20,000 feet, Johnston packers were set for 20 hours in 426° temperature and 22,045 psi hydrostatic pressure. Not one leak! They were pulled, redressed and run again, successfully. One was even used for the production packer after other brands failed!

Johnston packers set and release with simple movements. New rubber supports give greater rubber efficiency, allow more by-pass area for quicker and safer running as well as providing better pack-off performance.

Specially compounded rubber does not deform or deteriorate under extreme conditions. For instance, when the Full-Bore packer is released, it returns to original shape in a fraction of a second for quick, easy pulling. Unique gauge rings eliminate extrusion. Molly-coated slips reduce wear and friction. Hard, high-quality 4140 steel gives longer slip bowl wear.

Johnston packers are tough, built to give you the most accurate drill stem test available. And Johnston is continually working on more improvements. Another reason why Johnston Testers provides the best Drill Stem Test.

JOHNSTON TESTERS

Houston, Texas • Calgary, Canada

Professional Guidance Is Your Best Assurance of Success

With some luck, a lot of bass, and plenty of time, who needs a guide? And with twenty producing days a month, 3½ per cent money, and a quick payout, it was a lot easier to get ahead in the oil business. But, when you find that conditions aren't as you would have chosen, whether it's because only a few bass are hiding in the lake or because of drastically cut allowances, the time has come to call in the pros.

The Oil and Gas Loan Department of The National Bank of Commerce is ready to help you now. There are many ways to help, and lending money is only one function of this department. The Oil and Gas specialists in this department have already helped so many others. They've helped them back on the road to a profitable operation by helping them tighten their organization, cut costs by paring fat and not muscle.

The time may well have come when you must start living under the new conditions in the oil business. There's no better way to get started than by beginning to work with the Oil and Gas Loan Department of The National Bank of Commerce.

The oil and gas business is going to be around for a long time to come. Our experience and knowledge of all business can help you to get over the next few years, can help you to keep your organization intact and in good shape. Knowing the oil and gas business is one more reason so many leading independents are with us now. They need the best in banking, and the best in banking costs no more.

THE NATIONAL

BANK OF COMMERCE

OF HOUSTON

MAIN, TRAVIS AND CAPITOL

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

G and H
Offshore
FLEET
If it floats,
G&H Offshore
Can Tow It... Anytime
Specialists in Gulf Coast tidelands and deep sea towing. All assignments handled with speed, safety, efficiency and economy.
With diversified marine experience, G & H Offshore operates a modern fleet of diesel tugboats. Seasoned, licensed seamen are working partners in your offshore tow.
Call us today and let us help you plan your next towing job.
DISPATCHER DAY OR NIGHT PHONE Galveston SO 3-4673
Galveston Office SO 3-4331
STURGEON
G and H
OFFSHORE TOWING CO., INC.
COASTWISE AND DEEP-SEA TOWING
505 U. S. National Bank Building, GALVESTON

RIGGED SIMPLICITY BROWN

Fine Products

BACKED BY *Fine Service*

Mid-Continent Supply Co. store at Harvey, Louisiana.

Interior View of Sterling, Colorado warehouse of Bethlehem Steel Company Supply Division.

Lawrenceville, Illinois, store of The National Supply Company.

MID-CONTINENT SUPPLY CO.

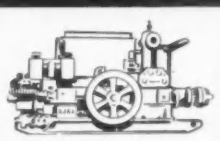
BETHLEHEM STEEL

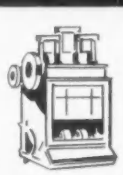
SUPPLY DIVISION

THE NATIONAL SUPPLY COMPANY

These distributors were selected by Ajax because they have a sense of service . . . a respect for fine products . . . and like Ajax, a consciousness of their obligations both to the customer and to the manufacturer.

ALWAYS A FULL DOLLAR'S VALUE IN AN AJAX PRODUCT





AJAX . . . builders of
ENGINES • COMPRESSORS • PUMPS

AJAX IRON WORKS CORRY, PENNSYLVANIA

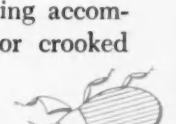
Oil Field Distributors

- The National Supply Co. — Pittsburgh, Pennsylvania
- Bethlehem Steel Co. — Supply Division, Tulsa, Oklahoma
- Mid-Continent Supply Co. — Fort Worth, Texas

RUGGED SIMPLICITY - - BROWN BOLL WEEVIL PACKERS

This low cost, easy to set, multiple purpose packer enjoys wide popularity because of its rugged simplicity. No special skill is required for setting and it may be reset numerous times while in the hole.

No rotation is required for setting or releasing—simple reciprocation of the tubing accomplishes either operation. Hence, the Brown Boll Weevil Packer is ideal for deep or crooked holes where packers requiring rotation to set cannot be used successfully.



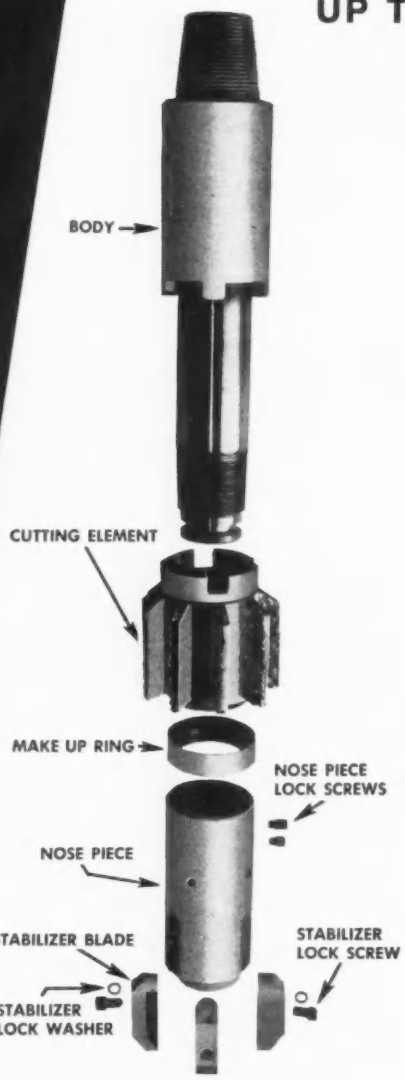
The button type slips in the built-in hydraulic hold-down are actuated by pressure from below the packer through a dead-end column. Thus, there is no flow behind the buttons. This feature prevents sand and other solids from sticking the buttons in the set position. The equalizing device is positively locked closed when the packer is set, but can be easily released by five rounds of right-hand rotation while picking up the tubing. This equalizes the pressure above and below the packer and across the hold-down buttons even if the tubing is plugged. *This time-proven* feature is another example of advanced design by Brown.

For your next job, remember the Brown Boll Weevil Packer—proven by successful settings in countless wells.

BROWN
OIL TOOLS, INC.
8490 KATY ROAD P. O. BOX 19236,
HOUSTON 24, TEXAS

MILLS LINERS UP TO 10′ PER HOUR!

THE *New* A-Z TYPE R PILOT MILL WILL MILL LINERS • STUCK WASH PIPE CASING • SCREENS N-80 AND P-110 GRADES UP TO 10′ PER HOUR



When you are next faced with removing a liner—consider the *time and dollar-saving advantages* of the A-Z Type R Pilot Mill rather than cutting and pulling. The cutting element of the A-Z Type R Pilot Mill has milled as much as 300′ before replacement at rates as high as 20′ per hour; averages exceed 100′ and 5′-7′, respectively.

Here is a better method, and tool, for better results that you can make use of with confidence of time and dollar savings. Talk to the A-Z representative now . . . or at least when you next face the problem.

FOR EXPORT: Reduced costs in inventory and shipping are realized by specifying the A-Z Type R Pilot Mill because extra cutting elements may be ordered with one tool.

The Type R Pilot Mill is just one of A-Z's family of "The World's Fastest Milling Tools." Write for your copy of the catalog today.

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5619 Fannin Street, Telephone JA 6-4794, Houston 4, Texas
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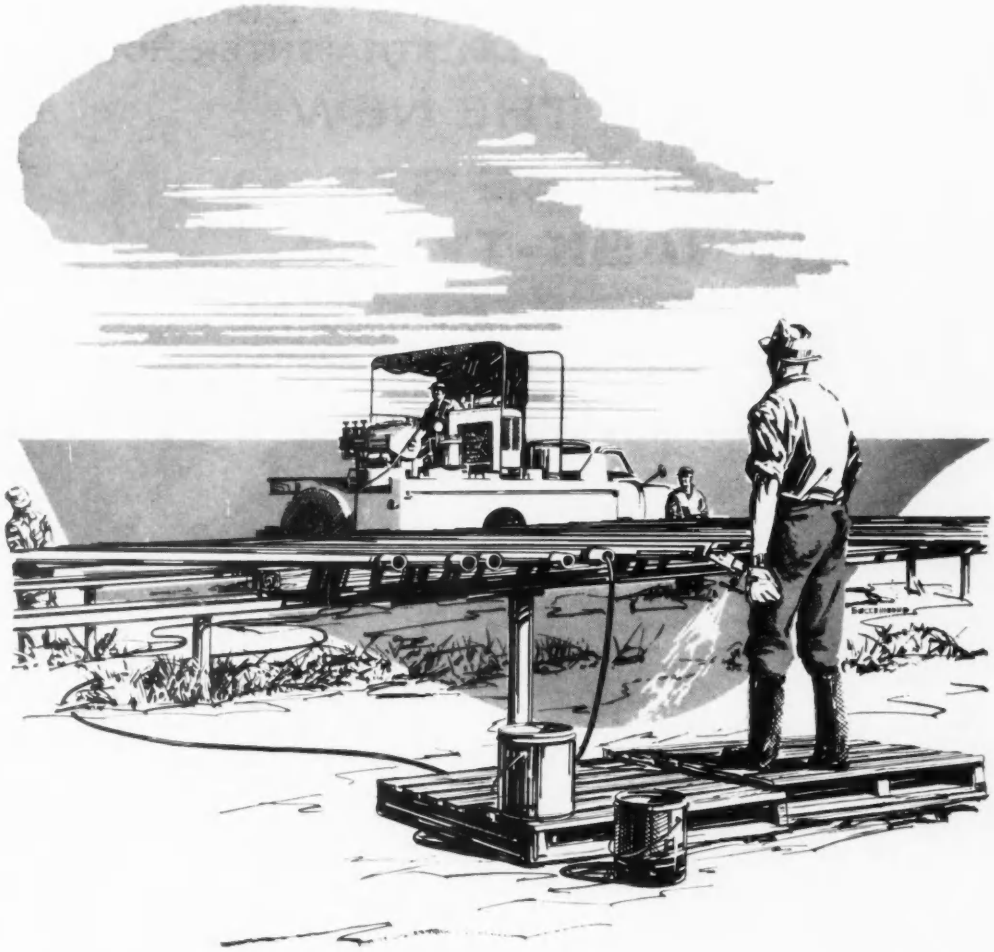
Maracaibo, Anaco, Las Morochas, Venezuela; Bogotá, Colombia

A-Z INTERNATIONAL
WORLD'S FASTEST MILLING TOOLS

For more data on advertised products, use Readers' Service Cards, last page.



Hydrostatic Testing

Another Service From ATLAS

Testing from one to one thousand joints is one of the additional services available from Atlas Pipe, your service-minded supplier of oil country steel tubular goods. Atlas hydrostatic field test units are strategically located in the Texas and Louisiana Gulf Coast area—as near as your phone, day or night.

"Of The Many, One Must Lead"

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A DIVISION OF ATLAS BRADFORD COMPANY
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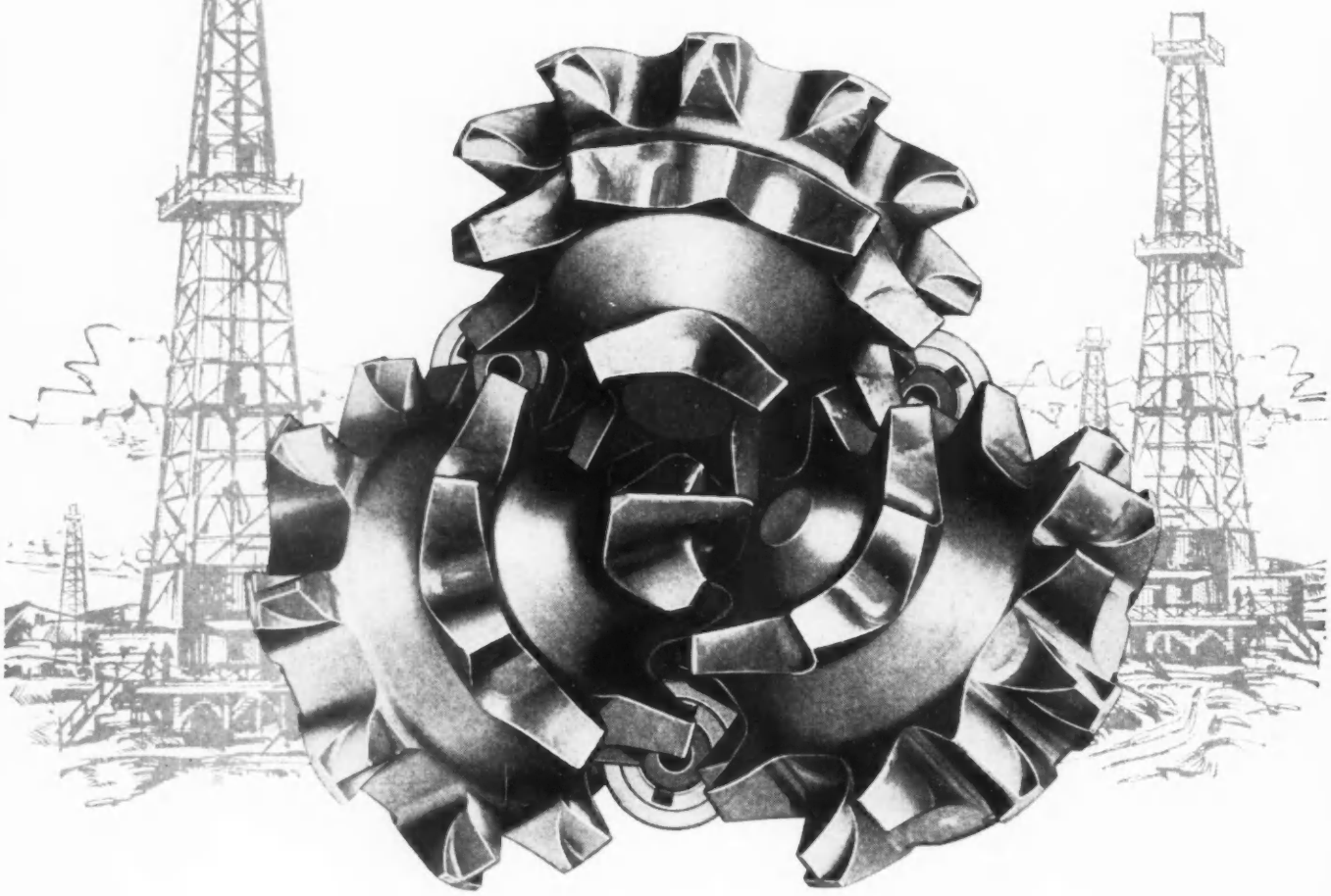
FOR FASTER LIGHTWEIGHT
DRILLING and STRAIGHTER HOLES

IT'S THE NEW

GLOBE ST3 "TASK-TYPE" JET ROCK BIT



Speeds penetration rate by drilling harder formations with a coarser tooth than normally used.

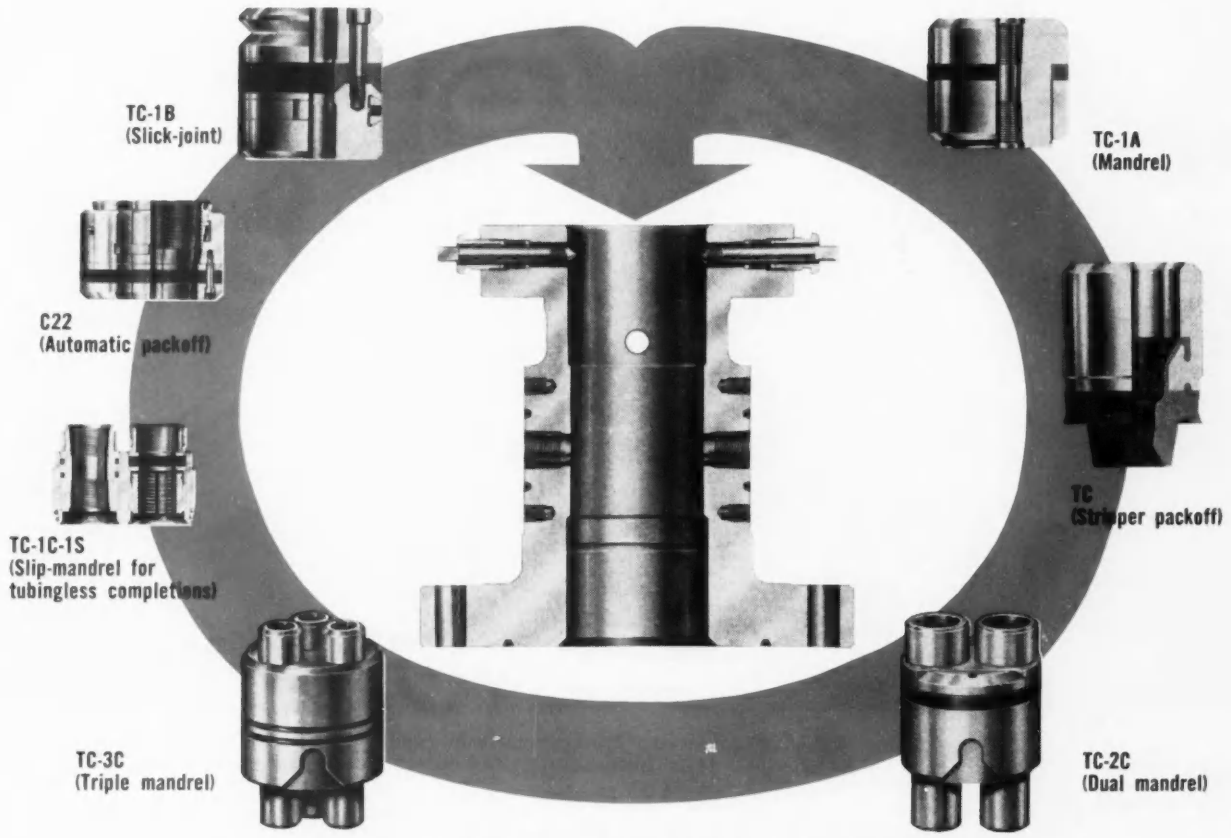
Maintains a straight hole when going through hard streaks interspersed with soft formation.

All Globe 3-Cutter "Task-Type" Rock Bits are available in both regular and jet types.

GLOBE OIL TOOLS

GLOBE OIL TOOLS CO.
Main Office and Plant: LOS NIETOS, CALIFORNIA
Branches maintained in all principal drilling areas

Now one O·C·T well head meets every need



O·C·T's TC MULTI-HEAD HANDLES TUBING or CASING, SINGLE or MULTIPLE COMPLETIONS

O-C-T's versatile TC Multi-Head helps you reduce your well-head inventory because you can use it on practically any well.

The TC Multi-Head suspends either tubing or casing. It accepts 13 different hangers for single, dual, or triple completions. These hangers provide either threaded or slip-type suspensions. All hangers for the TC Multi-Head can be furnished with O-C-T-Otis back pressure valve grooves.

The TC Multi-Head saves rig time because you need not replace it to change your completion plans. Just select the right hanger to meet your needs.

Complete control can always be maintained because all hangers pack off completely when landed. No packing or plastic sealer is added after blowout preventers are removed.

A full-opening 6-inch TC Multi-Head is available that permits running a 6¾-inch bit through 7⅝-inch casing.

See your O-C-T representative for complete information on the TC Multi-Head.

where progress is a daily practice

Several technical brochures are now available on O-C-T equipment, and others are being prepared. Write us for the brochures you want. Those now available include "O-C-T Flow Controls and Chokes," "O-C-T Independent Well Head Equipment," "O-C-T Tubingless Completion Well Head Equipment," "O-C-T Well Head Equipment for Storage Wells."

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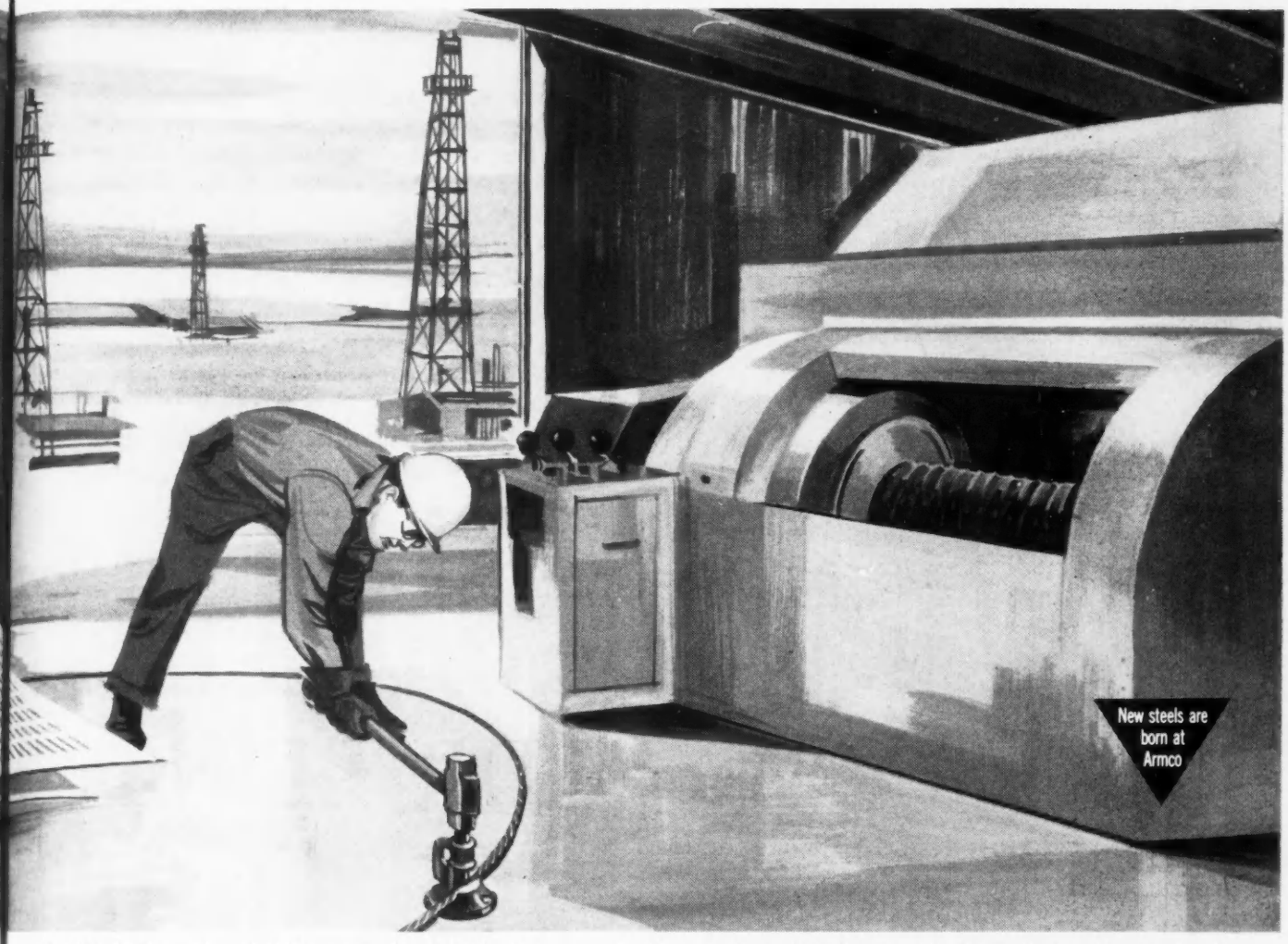
Electronic Brain Gave Union Tuffy®

Now, The Maximum Safe Ton-Miles of Service Are Charted for Every Drilling Operation

No more guesstimating! It took 462 charts and more than 600,000 calculations, but oilfield wire rope cut-off procedures are now scientifically based.

Union Tuffy has it all figured for you. The IBM "705" electronic brain gave him the ton-mile charts that tell you the right time to cut the right length of rope. You can be sure of maximum safe service for any drilling operation, anywhere in the world.



In '52, Union originated the workable oilfield wire rope cut-off procedure that has saved the industry thousands of dollars and man-hours, prevented many costly fishing jobs. Now made all-inclusive by electronically computed charts.

118,360 Answers to Cut-off Procedures

All the variables are taken into consideration—drum diameters, derrick heights, drill collar and pipe sizes, rope diameters, design factors, mud or air drilling, etc. It's all charted, 118,360 answers.

For you it's all simple and easy. Out of the mass of figures you work only from a few charts, maybe 5 or 6. From these it's no trick to regulate the cut-offs for all your drilling operations. We'll send a fieldman with full instructions and the specific tables you need.

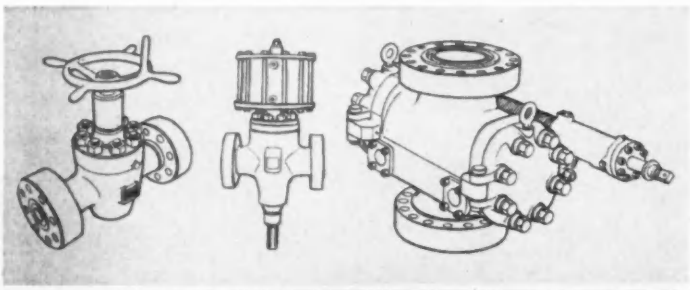
Scientifically right, too, are Union Tuffy Standard Rotary Line, Union Tuffy Jackknife Rotary Line and Union Oil Well Servicing Ropes including record breaking Uni-Core® Sand Lines. Union quality, flexibility and brute strength are fabricated into every powerful inch of them.

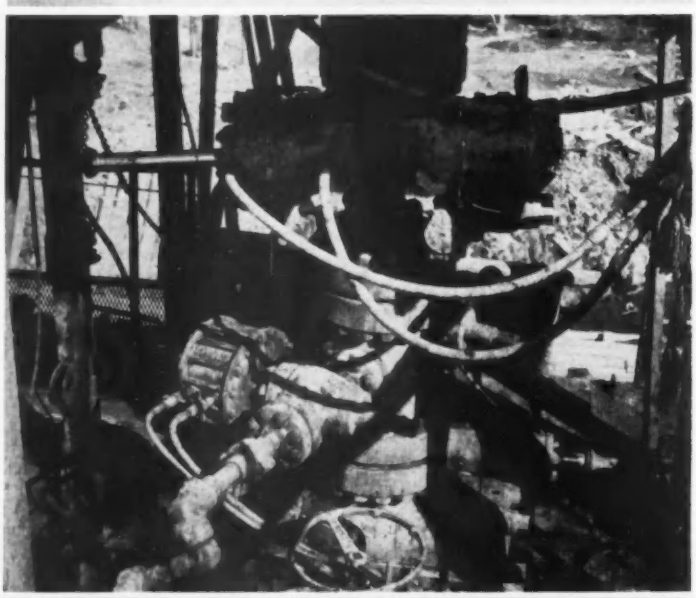
For fast, on-schedule delivery call your Union oilfield supply store.

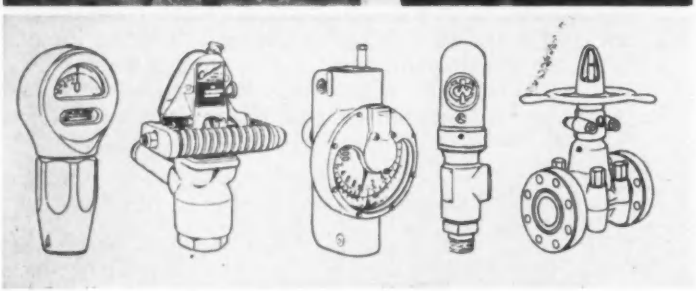
Person-to-Person Field Service

We bring this new electronic engineering service right to you. Simply outline your drilling plans. This will enable us to select the exact charts your operation calls for and a trained Union fieldman will bring them to you. He will explain their use to you and your crew. No extra charge for this service. **Write Union Wire Rope, Armco Steel Corporation, 2104 Manchester Ave., Kansas City 26, Missouri.**

ARMCO Union Wire Rope







Cameron introduced the first successful blowout preventer to the industry over 40 years ago. Since then, the control of pressures during drilling and workover operations has been our constant concern. The Type "F" Blowout Preventer is a product of our years of experience and continuing research and is now the standard of comparison for the majority of successful operators throughout the world.

Available in sizes 6" (7-1/16" bore) through 20" (20-1/4" bore) and in working pressure ratings to 15,000 PSI, Cameron Type "F" Blowout Preventers can be the most important part of your rig.

COMPLETE DRILLING CONTROL

Although blowout preventers are the central building blocks of your drilling control hookup, remember that all lines connected to it deserve equally careful attention. Cameron Gate Valves with their exclusive rotating seats are setting new records in long, trouble-free service on drilling control manifolds. These valves are available in sizes 2" to 6" and in working pressures to 15,000 PSI.

Cameron Type "F" Blowout Preventers and Cameron Gate Valves are furnished for hydraulic, pneumatic or manual operation, as specified.

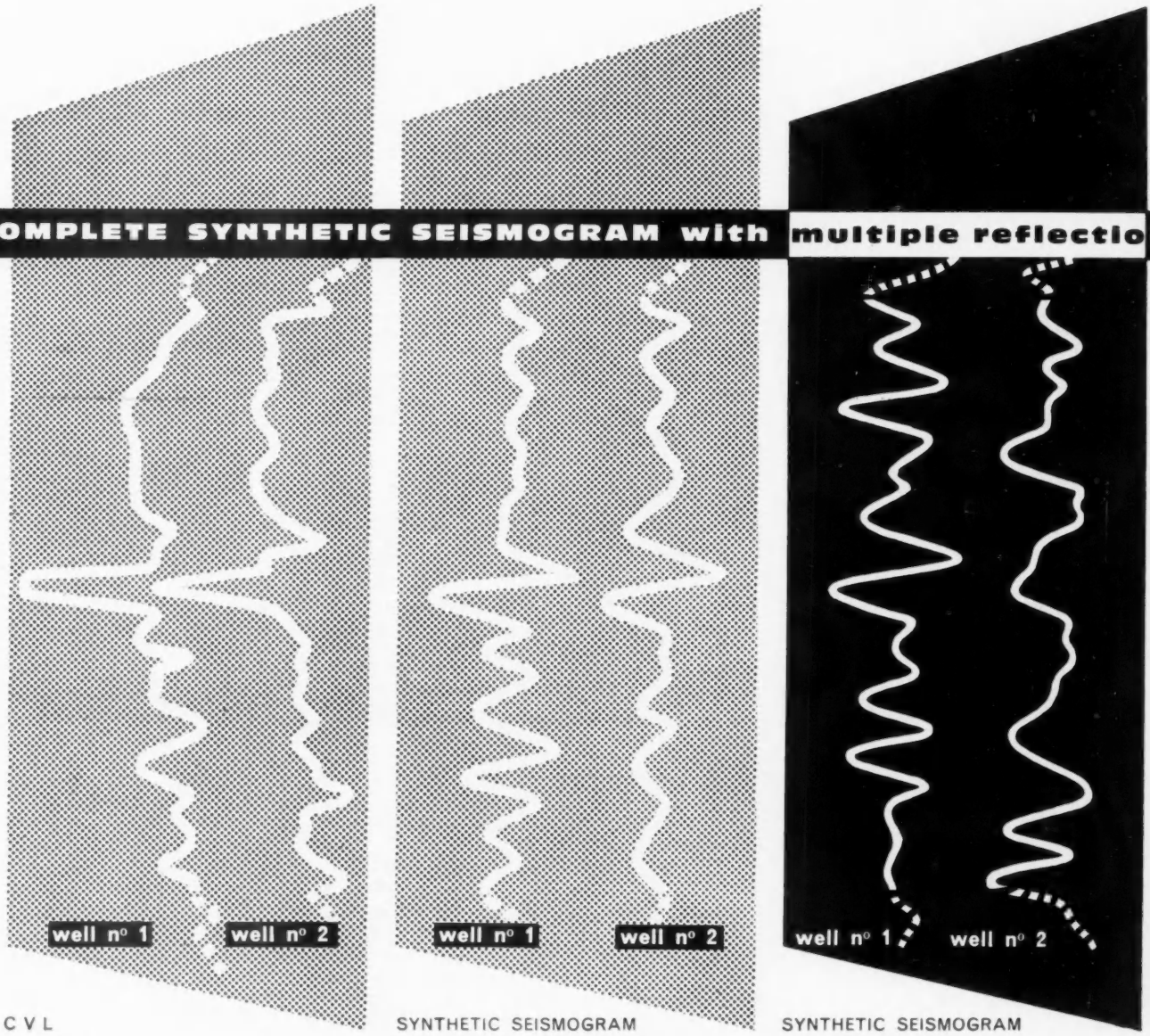
For complete drilling control go Cameron all the way.

Cameron

CAMERON IRON WORKS, INC.,
P. O. BOX 1212 • HOUSTON, TEXAS

A NEW METHOD OF IMPROVING THE PRESENTATION AND THE INTERPRETATION OF SEISMIC RECORDS

THE COMPLETE SYNTHETIC SEISMOGRAM with multiple reflections



C V L

SYNTHETIC SEISMOGRAM WITHOUT MULTIPLES

SYNTHETIC SEISMOGRAM WITH MULTIPLES

What geological and geophysical information can be obtained after synthetic seismograms are examined and are compared with the actual records ?

The synthetic seismograms make it possible to ascertain the existence and the quality of the horizons which may be used as good markers

The synthetic seismogram leads to improvements of the field techniques : automatic gain control and filtering

The synthetic seismograms are conducive to a more complete and more acurate interpretation

Using the synthetic seismogram your past and present surveys can attain their full value

The cost of a synthetic seismogram with multiple reflections varies with the depth logged : 20 to 25 % of the cost of the logging operations proper

For a borehole of average depth, this cost is no higher than that of one kilometer of seismic profile

YOU TOO WILL BENEFIT FROM THE USE OF THIS NEW GEOPHYSICAL TOOL

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Marsh Makes It!

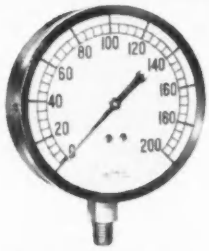
If it's a pressure gauge, dial thermometer, or needle valve, Marsh makes it...makes it in every form to suit every need...makes it better in the opinion of thousands of discriminating users. Only a few key products are illustrated here, but hundreds are described in Marsh Catalogs. Ask for information covering the product or products in which you are interested.

PRESSURE GAUGES

"Mastergauge"—the world's most effective pressure gauge for extreme service.

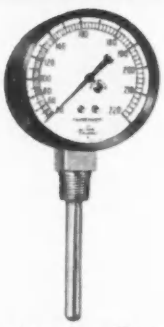
"Master-test"—"Mastergauge" quality in a gauge for services requiring high accuracy.

Quality series—second only to "Mastergauge" and "Master-test" for tough conditions.

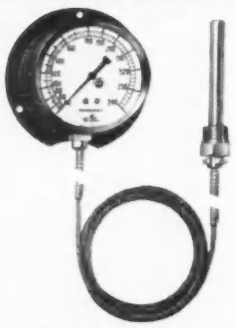


Standard series—best moderate-priced gauge for run-of-plant conditions.

DIAL THERMOMETERS

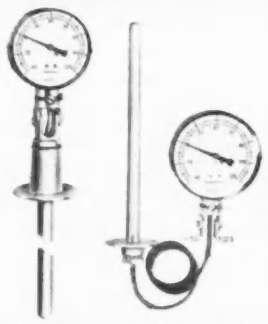


Vapor tension thermometers—direct mounted type. Many sizes; ranges.



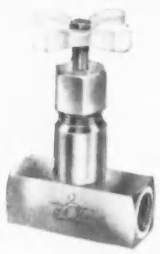
Distant reading thermometers—vapor-tension and gas filled types in many sizes; ranges.

Piping thermometers—specially designed for piping. Types for all purposes, including distant reading.

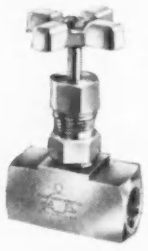


Duct thermometers—specially designed for all conditions including distant reading.

NEEDLE THROTTLING VALVES

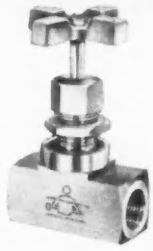


Alloy steel—complete series of sizes and patterns. Pressures up to 10,000 psi.



416 Stainless steel—complete series of sizes and patterns in 416 stainless. Pressures up to 10,000 psi.

316 Stainless steel—complete series of sizes and patterns in 316 stainless. Pressures up to 6,000 psi.



Panel mounted—all valves—alloy steel, 416 stainless, and 316 stainless—available in panel mounted types.

MARSH

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Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada.
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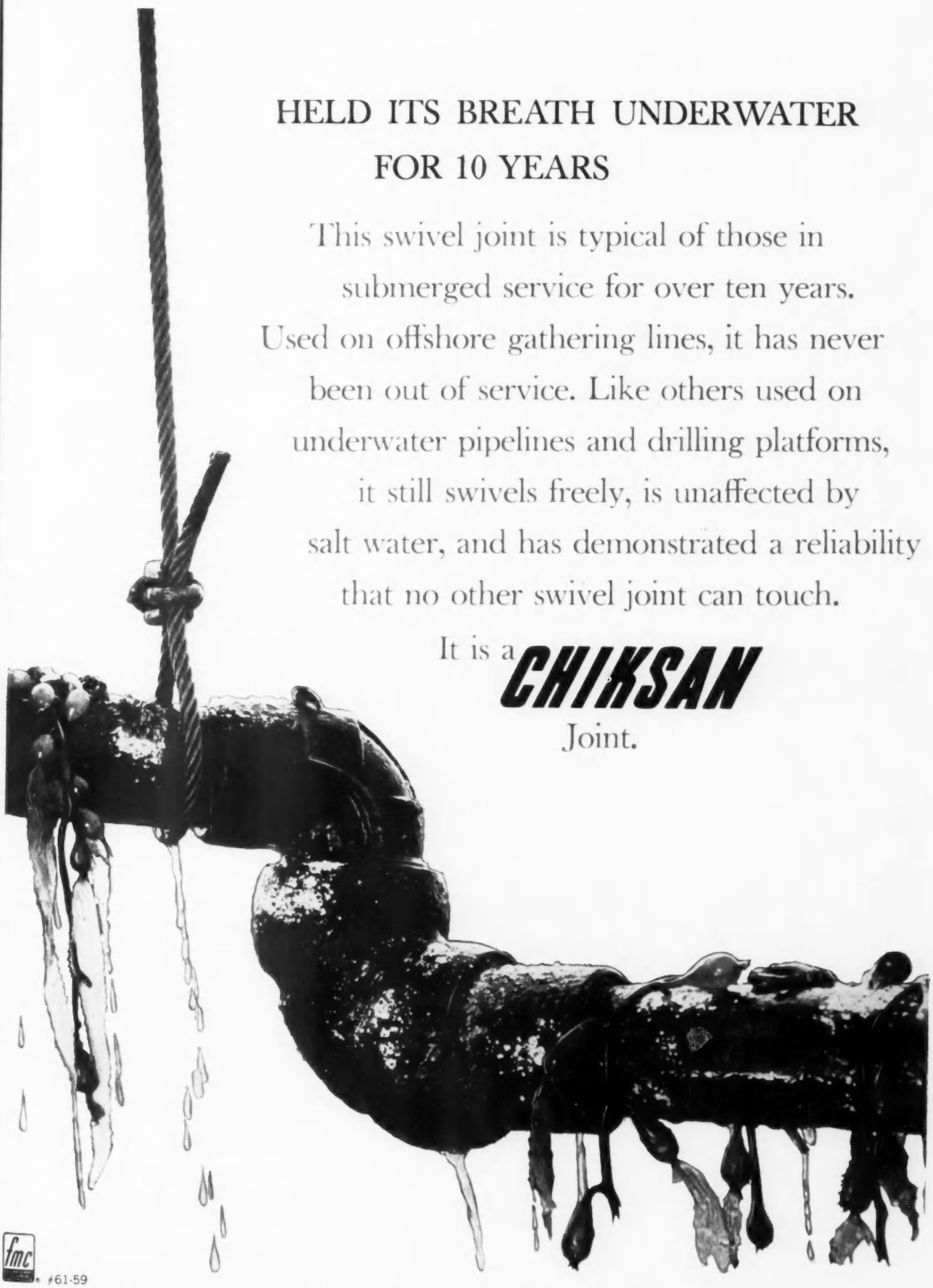
HELD ITS BREATH UNDERWATER FOR 10 YEARS

This swivel joint is typical of those in submerged service for over ten years. Used on offshore gathering lines, it has never been out of service. Like others used on underwater pipelines and drilling platforms, it still swivels freely, is unaffected by salt water, and has demonstrated a reliability that no other swivel joint can touch.

It is a **CHIKSAN** Joint.



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CHIKSAN COMPANY—General Offices: Brea, California • Well Equipment Mfg. Corp. Division (Weco Unions, Hamer Valves) • Chiksan International • Chiksan of Canada Ltd.

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TO HANDLE CAUSTIC SODA

Proof is a New Orleans dealer's experience. Drilling supplies of flake caustic soda, in both bags and drums, were stored offshore on a tender. When drilling was completed six months later, *all* excess bags were returned to stock in perfect, salable condition. Only a few drums could be salvaged.

Drums break open, corrode, leak, and often have to be scrapped. They take up twice as much storage space—are always a handling problem, individually or on pallets. Drums in bad condition often cause bad burns and compensation claims.

Diamond bags, with their sturdy Burlap-PE construction, are safer. The heat-sealed polyethylene insert keeps out moisture and water contamination. The tough outside burlap, saturated with asphalt covered with kraft, gives strength and sure grip.

Play it safe. Next time you order from your dealer or distributor, *specify* DIAMOND CAUSTIC IN BAGS. For further information, write Diamond Alkali Company, Cleveland 14, Ohio.

Diamond Chemicals

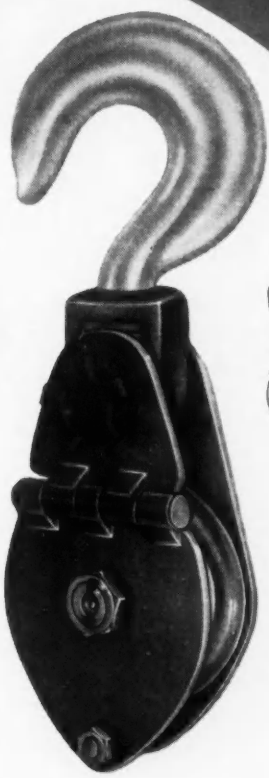
McKISSICK'S

NEW

Hinged Side Plate SNATCH BLOCK

DESIGNED FOR QUICK OPENING

- Acme threaded nut, less turns to tighten.
- Nut is integral part of hinged plate, for ease of stringing up. No nuts or bolts to lose.
- Drop-forged, heat-treated steel. High-speed bronze bushings, or HI-LOAD roller bearings. Alemite lubrication.



ONE TURN AND IT'S OPEN

McKissick

McKISSICK PRODUCTS COMPANY
Drawer 768 • Tulsa, Okla.

If crude came up in cans, casing and tubing wouldn't matter

But nature doesn't package her products. She requires you to wrench crude oil from the earth and carry it to the surface in tough steel arteries.

No tubular products handle this load better than CF&I Seamless Casing and Tubing. This top-quality steel pipe has the *straightness* that takes the kinks out of production problems . . . the *precision threads* and *strong joints* that prevent leakage and withstand high internal and external pressure. In addition, you can count on the quality *customer service* for which CF&I has long been noted.

CF&I Casing and Tubing meets API STD 5A specification and is available in sizes 2⅜" through 9⅝" O.D. Call your nearby CF&I sales office for complete details and speedy delivery. 8281

The Colorado Fuel and Iron Corporation
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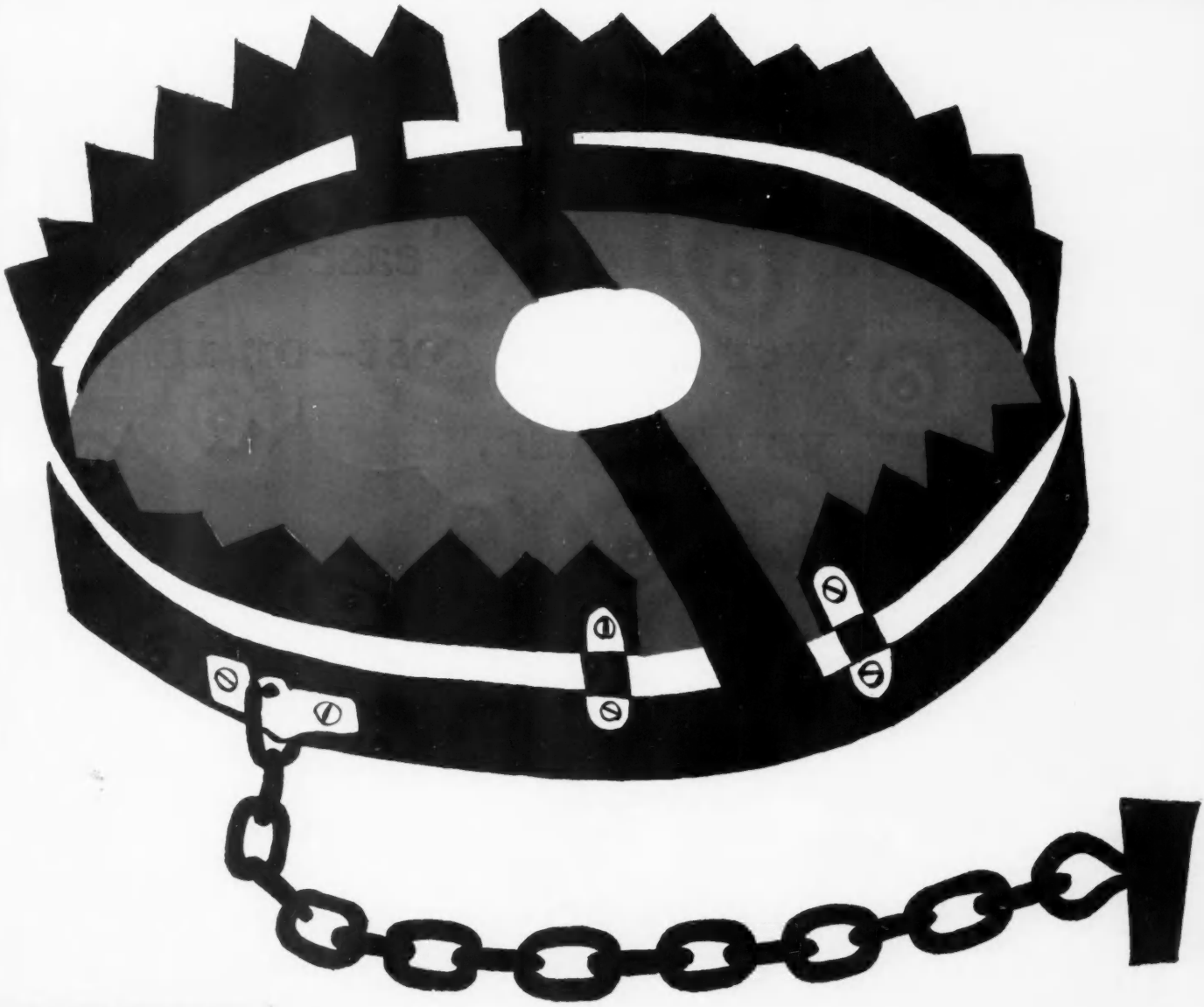

acts fast: There are times when a valve must shut off NOW! That's why you'll find Rockwell-Nordstrom valves in critical operations everywhere. With their smooth, fast quarter turn action and positive shut-off they're man's best friend in an emergency. It makes a lot of sense to use these same Rockwell-Nordstrom valves in all services—they cost no more. We'll be happy to send you complete information.

ROCKWELL-Nordstrom VALVES
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Rockwell International, S.A.
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Please send me Bulletin V-217.

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Company _____

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It will pay you to compare **Tideland** equipment with anybody else's for performance, long life, ease of maintenance, lower initial cost—or in any other way you choose.

1-MILE FOG HORN
Transistorized, fully electronic. Service and maintenance free. All electronic controls "packaged" for easy replacement. Ruggedized construction. Priced lower.
3-MILE FOG HORN
3.9 nautical mile range. Instantaneous starting in any weather—4 cylinders firing! Simple electronic control circuit. Takes 16% less deck space. Engineered for continuous heavy duty. Priced lower.
BEACON LIGHT
Transistorized, fully electronic. No mechanical failure. Automatic sun switch — No daytime drain on battery life. Complete master unit. Priced lower.

SEND FOR DETAILED LITERATURE

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Gentlemen: I'd like literature on the following products:
3 Mile Horn ☐ 1 Mile Horn ☐ Beacon Light ☐

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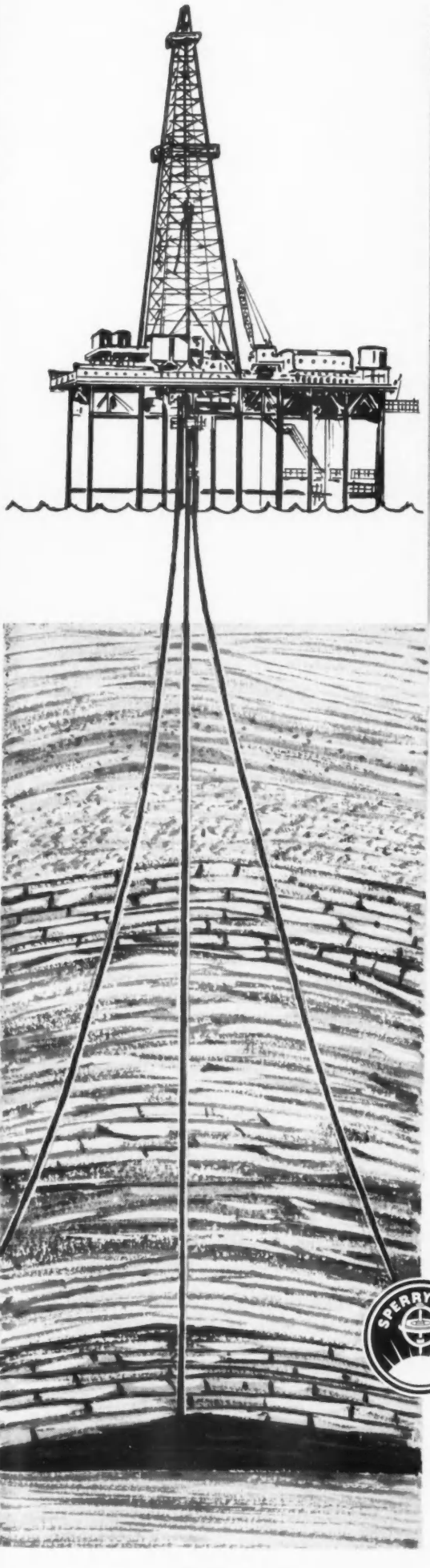
SPECIALTY CO., INC. / AIDS TO NAVIGATION

All Tideland equipment is of standard manufacture, can be maintained by **any** qualified maintenance man and is guaranteed to perform as claimed.



better instruments give better facts for better control...

METHODS AND DEVICES ORIGINATED BY SPERRY-SUN ESSENTIAL TO WELL SURVEYS AND DIRECTIONAL DRILLING

ORIGINATED first straight hole instrument (the Syfo Clinograph) generally accepted by the industry.

ORIGINATED only gyroscopic bore hole directional instrument in use in the United States.

ORIGINATED use of non-magnetic drill collars — an outstanding contribution to directional drilling.

ORIGINATED orientation of directional drilling tools in the bottom of hole. (Directional drilling could not be economically done without this Sperry-Sun method and the use of non-magnetic drill collars.)

ORIGINATED the taking of side wall cores.

And today Sperry-Sun leads with these better instruments and methods for better facts to give you better control on land or offshore:

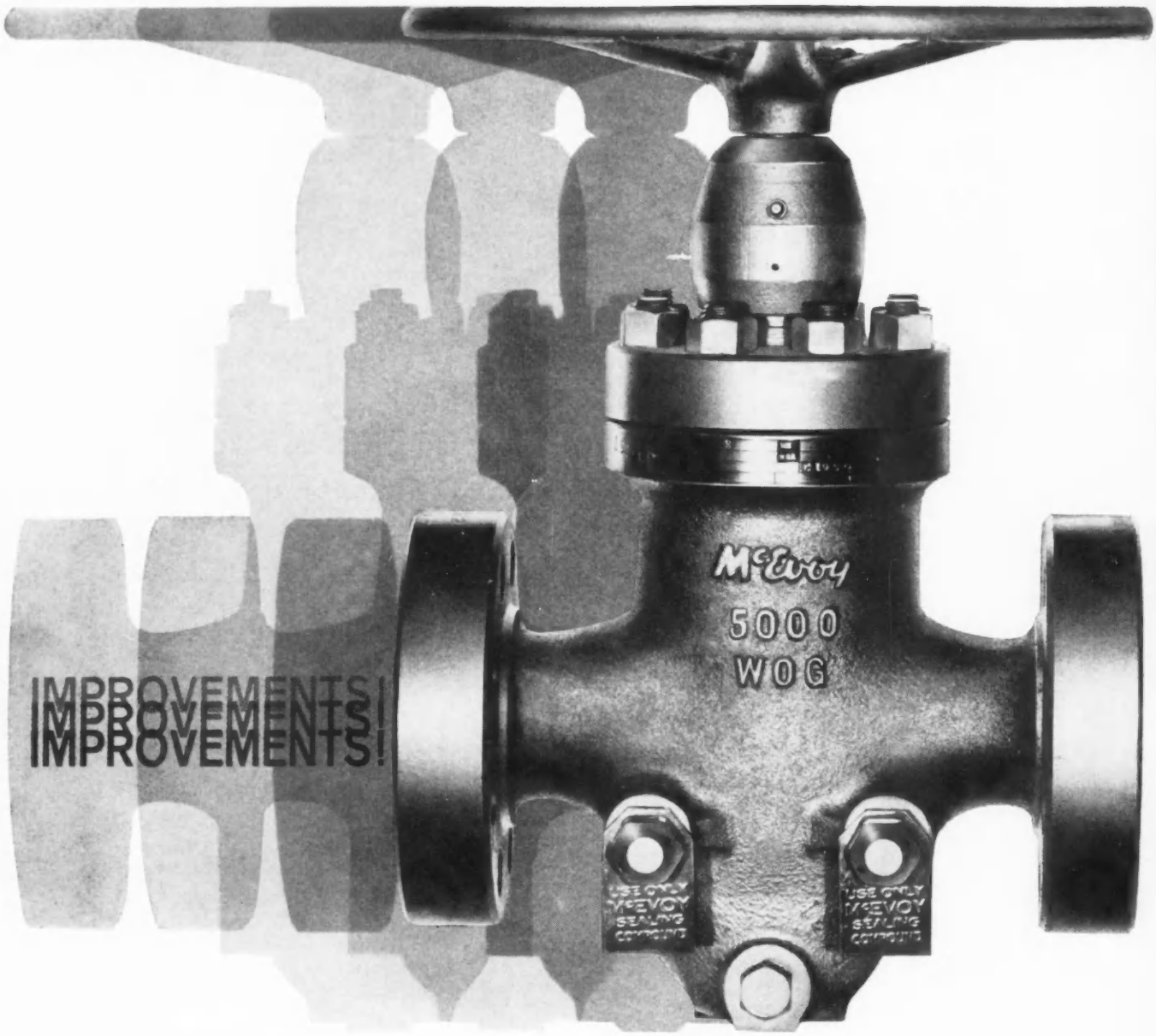
- SPERRY-SUN MAGNETIC DIRECTIONAL SINGLE SHOT
- SPERRY-SUN E-C INCLINOMETER
- SPERRY-SUN (MAGNETIC) MULTI-SHOT DIRECTIONAL SURVEYS
- SURWEL (GYROSCOPIC) MULTI-SHOT DIRECTIONAL SURVEYS
- K-MONEL NON-MAGNETIC DRILL COLLARS
- M-M-O MAGNETIC METHOD OF ORIENTATION

SPERRY-SUN WELL SURVEYING COMPANY

3118 Blodgett Avenue • Houston, Texas

Field Offices: Houston, Corpus Christi, Odessa, Marshall, Wichita Falls, and Pampa, Texas; Lafayette and New Orleans, La.; Long Beach, Bakersfield and Ventura, Calif.; Oklahoma City, Okla.; Brookhaven, Miss.; Casper, Wyo.

For more data on advertised products, use Readers' Service Cards, last page.

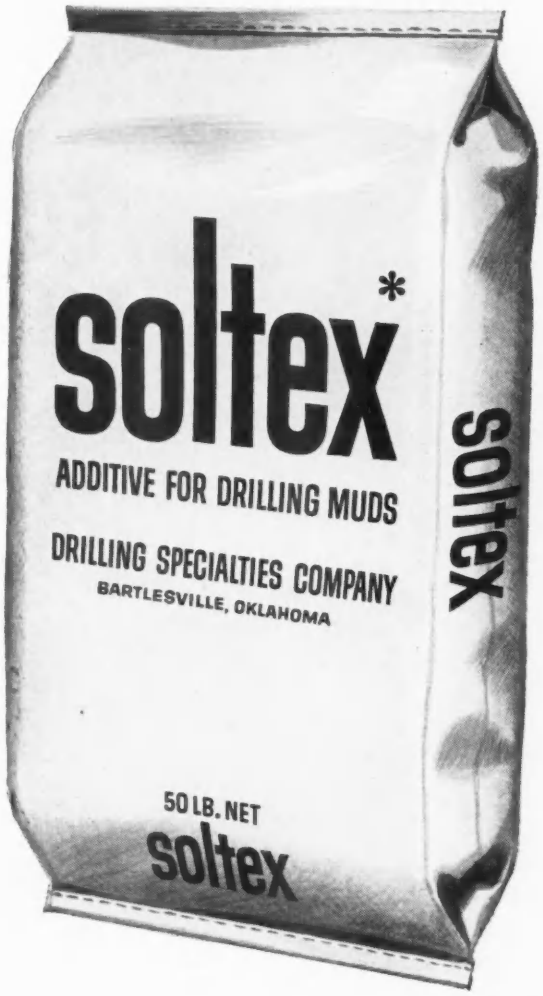


All through the valve that "couldn't be improved!"

It didn't leak. Required precious little servicing. Gave positive, tight shut-off from both directions. Let's face it—the Model "B" McEvoy valve was so good it built our reputation. Leave it alone, we were told. But McEvoy engineers didn't. They tested hundreds of possible improvements . . . field-tested each separately and thoroughly. The result was seven major improvements—and we've put them all in the new McEvoy Model "C" valve we're now delivering. Being alert to valve improvements, you owe it to yourself and your company to specify and use the new McEvoy Model "C" Gate valves.

McEvoy **COMPANY / OIL WELL EQUIPMENT**

TEXAS AND MILBY STREETS • P. O. BOX 3127 • HOUSTON 1, TEXAS



....Replaces Oil in Drilling Muds

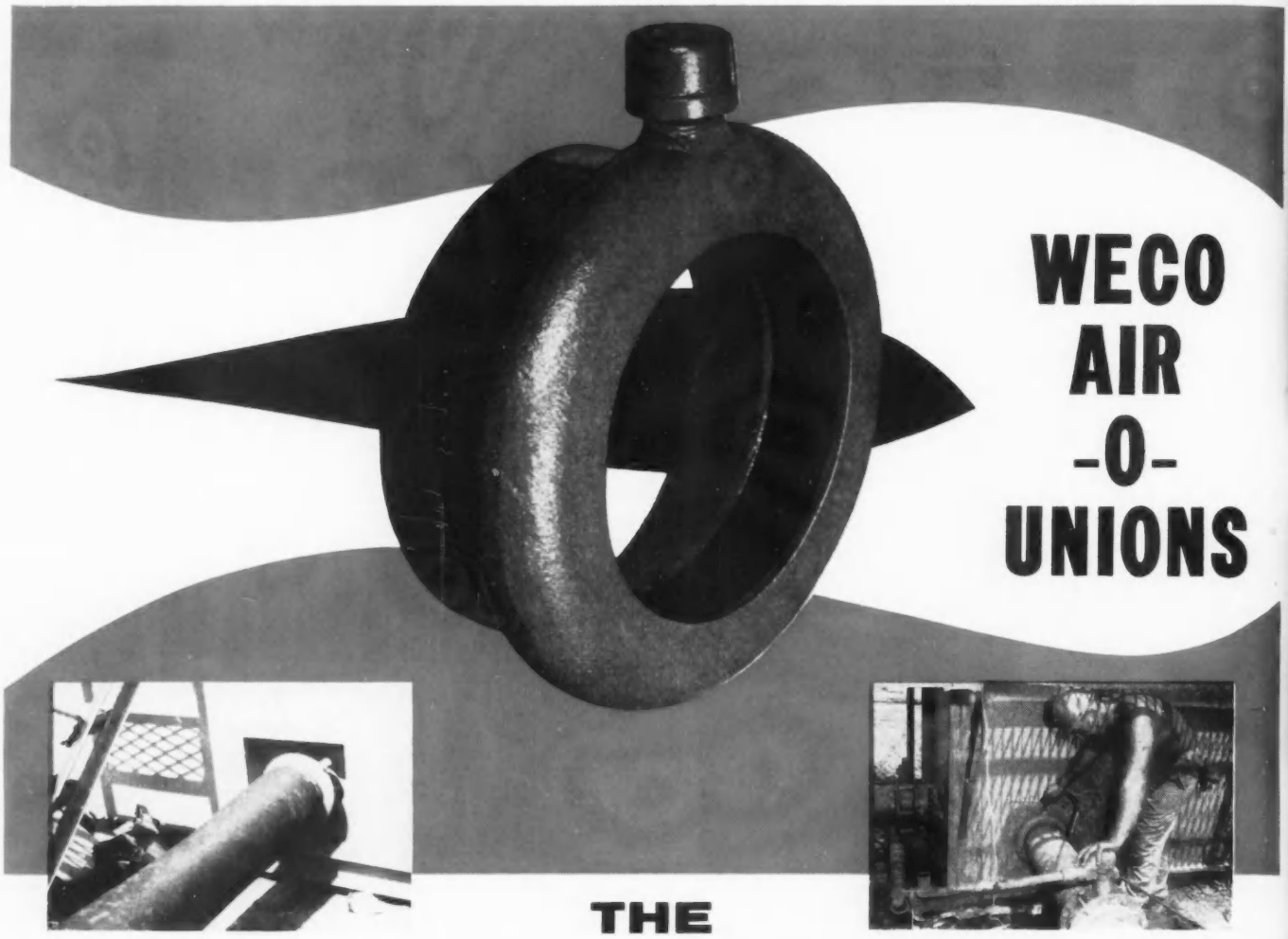
SOLTEX is a new and extremely versatile mud additive. One of its many uses is to replace oil in drilling muds . . . except where oil is used for weight reduction. In well after well, SOLTEX has proved that it gives the advantages of oil . . . *without* many of its disadvantages.

SOLTEX provides lubricity, reduces torque and drag, reduces pipe sticking, extends water loss control, and stabilizes the mud system. SOLTEX does not require extra weighting material as does oil when used in weighted muds. It does not require an emulsifier or limit the use of other mud additives. SOLTEX does not soften the filter cake and cause it to pull loose. On the contrary, it adds to the texture of the filter cake and keeps hole sloughing to a minimum. SOLTEX remains stable at high temperatures. Geologists prefer SOLTEX because it does not affect the fluorescence of cuttings.

*A trademark

Perhaps SOLTEX can help solve your mud problem or save you money. For information on the many uses of SOLTEX—see your Drilling Specialties Representative . . . or contact your mud dealer.

DRILLING SPECIALTIES COMPANY
Bartlesville, Oklahoma



WECO AIR -O- UNIONS

THE LOW COST UNION FOR LOW PRESSURE LINES

If you are looking for new economies, here is a way to save money and maintain efficiency on your drilling rigs. Use WECO Air-O-Unions on the mud suction and return lines as well as all other low pressure lines on the rig.

Their initial low cost is just the beginning of your savings. Make-up time is only a matter of minutes. With the Air-O-Union welded in place, plain pipe is inserted and the seal completed with a shot of air. No bolts, nuts or wrenches are required . . . no close line-up is necessary. Seal is not affected by vibration, misalignment or pipe expansion. To break out, just deflate the tube.

Switch to low cost, time-saving, simple WECO Air-O-Unions on all low pressure lines and start economizing with your next rig-up. Air-O-Unions, in sizes 4" through 16", are available from your supply store . . . or ask your WECO or Chiksan representative.

WELL EQUIPMENT MFG. CORP.
P. O. BOX 19465 • HOUSTON 24, TEXAS
Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

AO-2-61

WECO UNIONS | CHIKSAN SWIVEL JOINTS | HAMER LINE BLIND VALVES | HAMER PLUG VALVES | WECO AIR-O-UNION | WECO COMPOUNDS | WECO SNATCH BLOCKS

Autocar "Loggers' Special" carries 8000 board feet of pine over rugged mountain roads.

Autocar "Oil Field Special" hustles heavy oil rigs all over the world.

Autocar "Michigan Special" hauls 47-ton payload, making the most of Michigan laws

Custom Builders to the Trucking World

Wherever hauling duties are rugged and steady . . . wherever maximum performance is crucial, back comes the message, "We need Autocars . . . nothing less."

So you find Autocar hauling oil equipment over the shifting sands of Libya, carrying maximum legal loads under the many varying state laws, doing the ruggedest off-the-highway/over-the-highway work.

Every Autocar is custom-engineered from "rubber to roof" for its specific job. Components are perfectly matched throughout its design and construction—always with an eye to quality. Frame rails, for example, are made of the finest steel . . . custom-drilled to avoid unnecessary holes and to assure perfect alignment of components.

For you, Autocar produces just the truck, at a reasonable cost, that will earn the most on your investment. Buy less if you can afford it—but where every dollar counts, buy the "World's Finest."

Autocar
"World's Finest"

Division of
THE WHITE MOTOR COMPANY
Exton, Pa.

Reed Cobra bits are just one example of

Dowell provides electronic computer calculations to help operators select best frac treatments

Dowell's new electronic computing service is now providing rapid calculations – based on the Frac Guide* – to help operators select fracturing treatments best suited to their needs and available funds. This new service by Dowell costs you nothing extra, yet it offers operators new opportunities for greater profits from fracturing.

The computer provides calculations comparing the effects of different fracturing fluids, injection rates and propping agents for a given set of well conditions.

The computer output shows predicted production increase, treatment cost and payout for each treatment analyzed. These data can be plotted on graphs to give the operator a visual comparison of the treatments being considered.

The big advantage of Dowell's computing service lies in speed of calculations. Until now, it took an engineer something like a full day to calculate a single treatment with only a few variables. The computer requires less than ten minutes. This, coupled with Dowell's nation-wide teletype system, makes it possible to provide customers with many calculations quickly – usually in only a few hours.

Accuracy is another advantage. The computer minimizes the possibility of error in calculations and frees engineers to double check input data for accuracy and completeness. The result is more accurate, more reliable calculations than ever before.

Again, Dowell is helping operators improve fracturing results. Again, there is no extra cost. Ask for full information. Dowell services and products are offered in North and South America, Europe and North Africa. Dowell, Tulsa 1, Oklahoma.

*DOWELL SERVICE MARK

SERVICES FOR THE OIL & GAS INDUSTRY

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

Reed Cobra bits are just one example of the outstanding economies made possible by Reed's continuing program of research and development. These bits are setting phenomenal records all over the oil country in both mud and air drilling. For example—

On a West Texas well, drilling with mud below 12,000 feet, four Reed Cobra bits drilled 2,289 feet in 404½ hours. On an offset well it took 37 tooth bits to drill 2,172 feet in 558 hours. On another West Texas well a Cobra bit set an air drilling record of 3,644 feet in 103 hours.

In Pennsylvania, drilling with air, it is routine for one Reed Cobra bit to complete the hole from surface casing to TD. In this area total footage per Cobra bit regularly exceeds 7,000 feet.

Drilling with mud in East Texas in the tough Travis Peak formation Cobra bits consistently get runs up to 250 feet. Drilling with gas in Mississippi 10 Cobra bits drilled 6,850 feet in 358½ hours. In the same vicinity more than 10 times this number of tooth bits were required to drill the same footage with mud.

There is a Reed man near you. Let him give you the full story on Reed Cobra bits and the Reed Quality Line—tool joints, drill dollars and rock bits.

PIONEERS IN EFFICIENT DESIGN

REED COBRA BITS

IN MUD OR AIR

PENNSYLVANIA — 1 COBRA BIT, 8,352 FEET IN 134½ HOURS

WEST TEXAS — 1 COBRA BIT, 3,644 FEET IN 103 HOURS

FOUR CORNERS — 1 COBRA BIT, 4,102 FEET IN 134½ HOURS

MISSISSIPPI — 1 COBRA BIT, 1,317 FEET IN 51¾ HOURS

REED ROLLER BIT COMPANY

HOUSTON 1, TEXAS • Export Office: Time and Life Bldg., Suite 3744 Rockefeller Center, New York 20, N. Y.—Reed Roller Bit Company (Nederland) N. V., Rooseveltstraat 6, Leiden—Reed Roller Bit Company, Ltd., 4431 6th St. S.E., Calgary, Alberta.

SHEFFIELD Best in Bolts Since '88

Strong
Tough
Economical
Efficient
Lasting

Steel

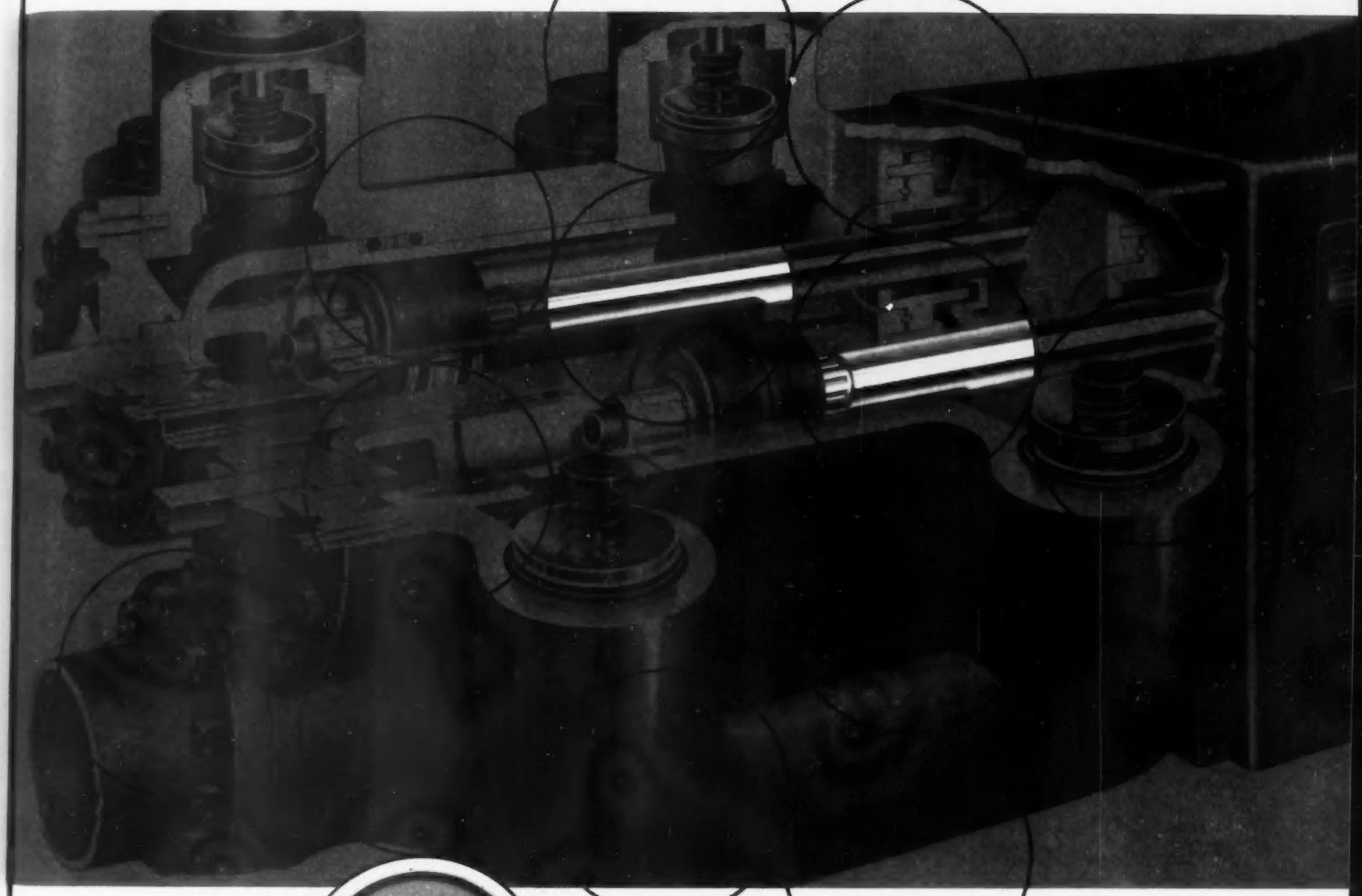
Big Bolt Plant

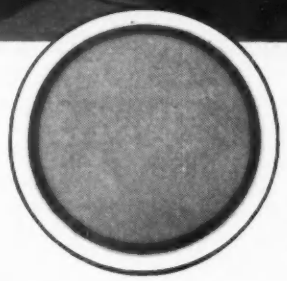
Research

It starts with YOU. As a customer you are a key member of Sheffield's research staff. You have a new need that calls for action. Sheffield's research people with big-plant resources can take it from there. ▪ New metals, new metal-working methods, new machinery, new applications are all part of a continuing study by Sheffield metalurgists, engineers and research experts. Their life-long interest is better bolts. ▪ Sheffield is one of the world's largest integrated bolt plants. Here you have a complete line from a single source—bolts, cap screws, rivets—thousands of standard and special types. Sheffield all the way from furnace to finish. Quick shipment. Ask your Sheffield bolt man. **Sheffield Division, Armco Steel Corporation—Houston, Kansas City, Tulsa.**

ARMCO Sheffield Division

Mission rods are here to stay





because Mission Super-Chrome rods have wearing surfaces

Ordinary rods must fight corrosion fatigue as well as the fatigue from tensile and compressive stresses. But, the tough, hard-chrome plating you see in the photograph protects Mission Super-Chrome® rods against corrosion fatigue. That's one more reason Mission rods last longer. Beneath the coat of heavy chrome you can see the deep, file-hard case. Inside is the tough, high strength core. Its unusually high ductility will resist the fatigue induced by literally millions of tension and compression cycles, while the chrome plating resists the corrosion fatigue which could be induced by millions of gallons of drilling fluid. Mission Super-Chrome rods are sure to stay in your pump longer than any others. Specify Mission parts all the way and save all the way.

MISSION MANUFACTURING CO.

MISSION MANUFACTURING CO. P. O. Box 4209, Houston, Texas Cable Address "MISSCO" Export Office: 30 Rockefeller Plaza, New York
In the United Kingdom: MISSION MANUFACTURING CO., LTD., 1 Hanover Square, London W. 1 England • cable address "MISSOMAN"

PREPARING FOR PROFIT IN DEEP SLIM-HOLE TEST

THIS HALLIBURTON TESTER is assembling the Hydro-Spring Tester in testing string before running a deep slim-hole test. He will provide a major oil company with formation pressures which the operator needs for reservoir evaluation. From this he will decide whether or not to case and complete the well.

In these days when cutting costs is such an important factor in showing a profit from operations, more and more operators are calling Halliburton to run their formation tests. Through the years, they have come to trust Halliburton's experience to get testing results — not claims.

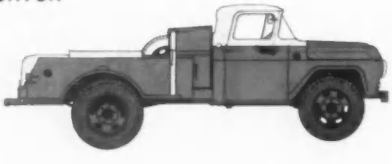
WHAT ABOUT THIS WELL? She proved out to be a real producer. The operator completed it after formation tests between 9,000 and 9,400 ft. showed excellent potential.

Interesting results include:

First zone tested . . . 9,362-9,409′ Cook Mountain Sand #3
Test duration . . . . . 4 hours
Fluid recovered . . . 33.6 Sp. Gr. Crude @ 63 bbl flow during test through ¼″ surface choke
Tubing pressure . . . 650 psi
Tubing size . . . . . 2⅜″ O.D.
Oil to gas ratio 694/1

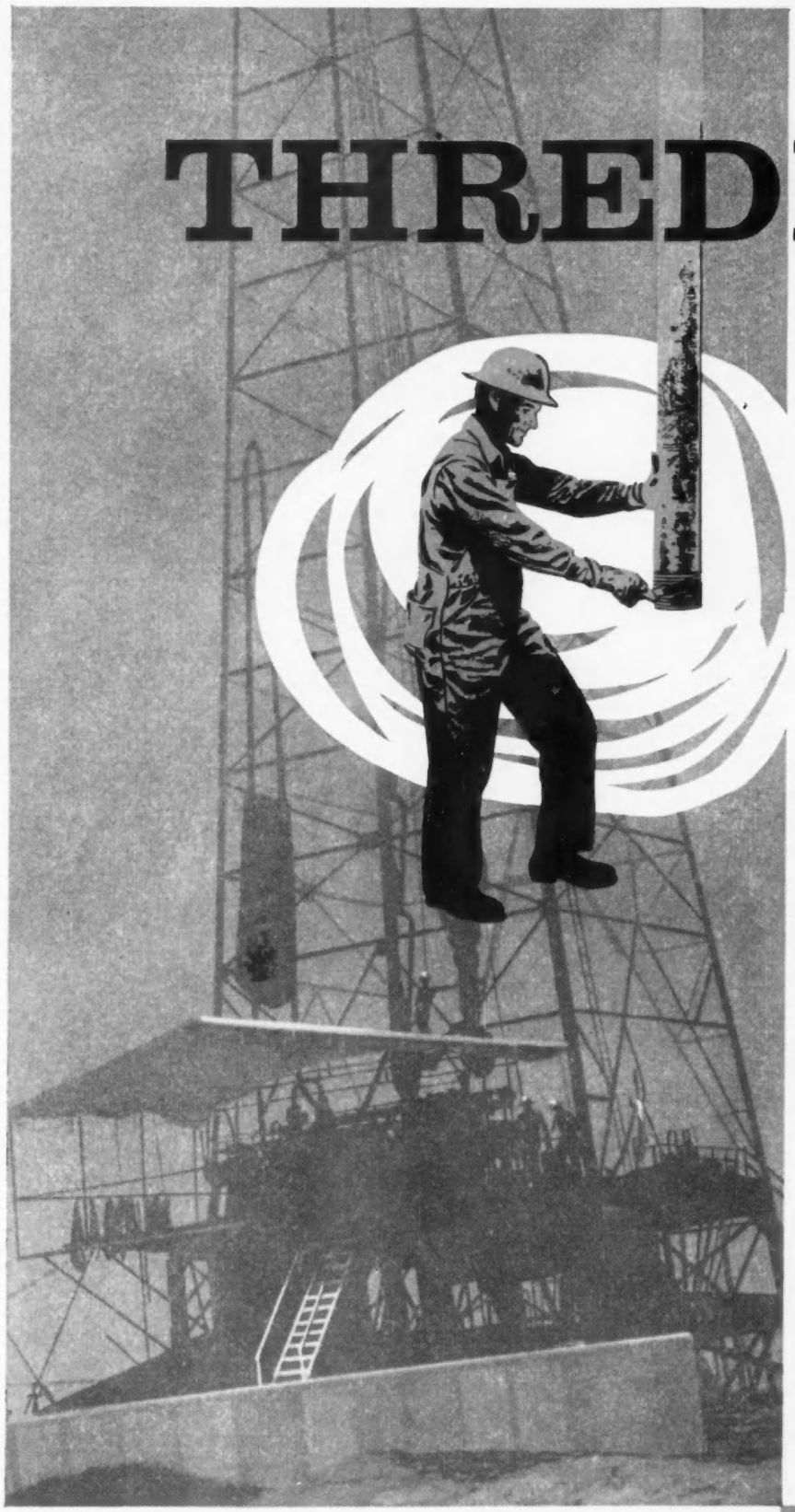
Second zone tested . . 9,200-9,216′ Cook Mountain Sand #2
Test duration . . . . . 2 hours
Fluid recovered . . . 34.2 Sp. Gr. Crude @ 47½ bbl flow during test through ¼″ surface choke
Tubing pressure . . . 1,075 psi
Tubing size . . . . . 2⅜″ O.D.
Oil to gas ratio 275/1

RELY ON FACTS IN FORMATION TESTING . .
RELY ON HALLIBURTON



TESTING SERVICES

Halliburton
COMPANY • DUNCAN, OKLAHOMA



THREDLOK®

The **best** way to lock casing... **saves $40 to $90** per string!

THREDLOK Compound seals casing tighter and stronger than tack welding . . . prevents possibility of heat damage to tempered, high-strength casing. Yet THREDLOK costs *less* than welding!

With THREDLOK, your own crew can lock and seal the lower joints in a casing string for about $10.00. Out-of-pocket costs of welding would be approximately $50 to $100. So THREDLOK saves you $40 to $90 *cash* per string. And the extra protection THREDLOK gives casing threads can save you much more.

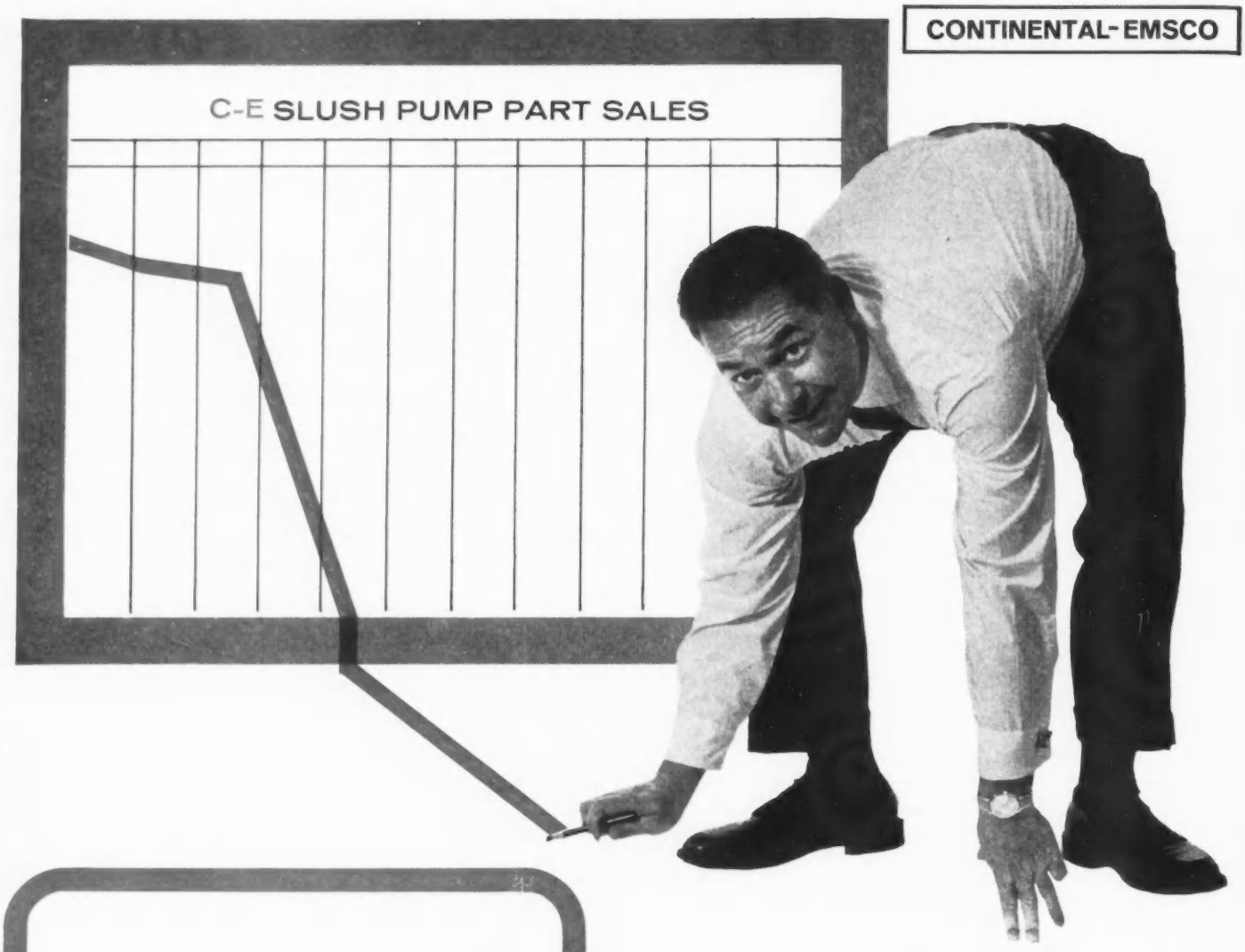
Get THREDLOK next time you run casing. Available through Humble Bulk Plants, marketers, or contact Humble Oil & Refining Company, Houston, Texas.

America's Leading ENergy COmpany

HUMBLE

YOU SAVE WHEN YOU DO BUSINESS WITH

CONTINENTAL-EMSCO



SALES ARE OFF
on slush pump parts
AND WE LIKE IT!

Considering the great number of Continental-Emsco slush pumps running, orders for replacement parts are surprisingly few. This we like. Our customers like it even better. It means they are able to keep drilling contracts *on schedule* with less costly downtime.

Routine maintenance on C-E pumps is fast and simple, with automatic lubrication . . easy-to-open valve pot covers for quick valve inspection or replacement . . "exposed" liner design to help prevent washouts and "sanding-up." These and many other Continental-Emsco pump features have been proven under the world's toughest drilling conditions for nearly 25 years.

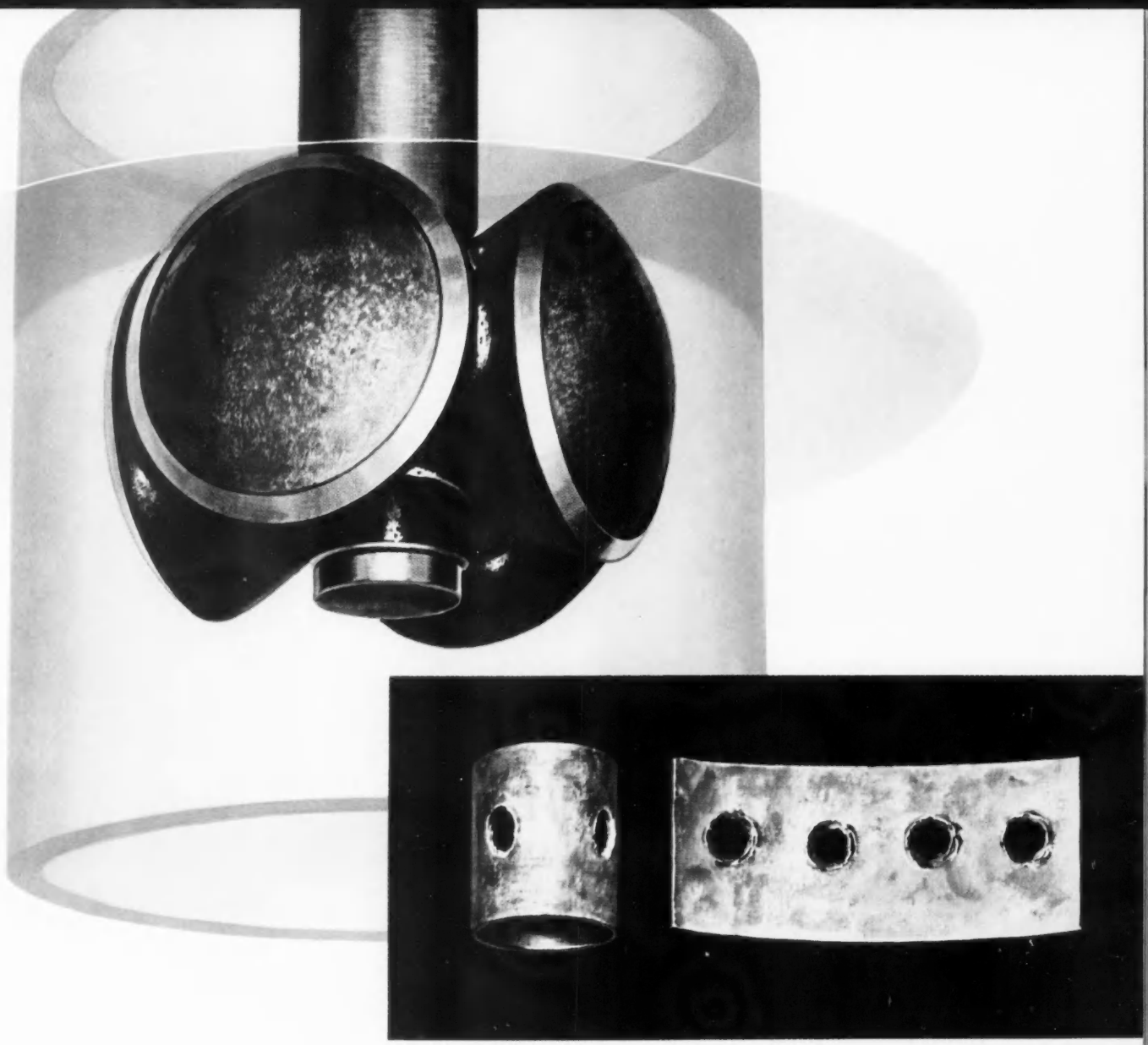
You can cut your parts bill and downtime, too. Call a C-E man and talk slush pumps.

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries . . Worldwide

SP 104

CONTINENTAL-EMSCO COMPANY, a Division of The Youngstown Sheet and Tube Company, General Offices: Dallas, Texas; Export Division: 30 Rockefeller Plaza, New York, N. Y. • Continental-Emsco Company Limited, General Offices: Calgary, Alberta, Canada Continental-Emsco Company C. A., Caracas, Venezuela • Plants: Houston and Garland, Texas; St. Albans, Herts, England • *Representatives in All Principal Oil Fields of the World*



The Schlumberger Radial Jet acclaimed revolutionary by production men

Lower breakdown pressures, higher injection rates, production without stimulation . . . all have been achieved through perforations made with this fast, efficient, and economical new gun.

The Radial Jet fires a cluster of powerful shaped charges in a single plane. Depending upon the casing size, the cluster contains three, four, or five charges. Spacers permit the simultaneous shooting of several clusters as much as three feet apart.

The perforations—1″ or more in diameter—are ideal for operations requiring large, high capacity holes into the formation.

Since the holes from a cluster are made in a single plane, the gun is particularly advantageous for pinpoint fracture initiation. For the same reason, the Radial Jet is appropriate for thin zone production, treated or not.

The Radial Jet can help you make better completions at lower costs. Ask the men who have used this revolutionary new gun.

SCHLUMBERGER

THE EYES OF THE OIL INDUSTRY

NBT . . . YOUR KEY TO MODERN OIL FINANCING

OIL LOANS

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

NATIONAL BANK OF TULSA

THE OIL BANK OF AMERICA

OFFERING COMPLETE BANKING AND TRUST SERVICES

AN EXPERIENCED OFFICE FOR THE OFFSHORE DRILLING CONTRACTOR

Maritime

INSURANCE AGENCY, INC.

827 PERDIDO ST. • JA 5-7011

NEW ORLEANS

Libya Oil Maps

Jack Ammann, Inc., has geological maps of Libya, immediately available to assist you in locating concession areas of the most promise in this vital region.

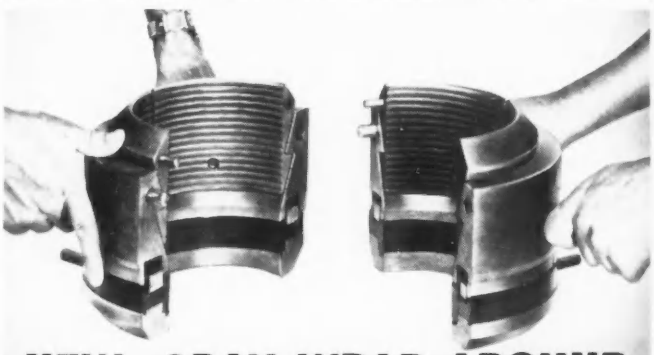
WE CAN FURNISH:
PHOTOGEOLOGIC MAPS
CONCESSION MAPS
TOPOGRAPHIC MAPS
AERIAL PHOTOGRAPHS
MOSAICS
PLANIMETRIC MAPS

Our maps and services are immediately available to you for the Libya area, the Rocky Mountain region of the U.S., Alaska, or anywhere in the world.

Write for New Complete Brochure of Our Services

30 Years of Service to the Oil Industry

JACK AMMANN, INC.
ENGINEERS and SURVEYORS
Broadway at Tenth, San Antonio 5, Texas, U.S.A.



NEW: GRAY WRAP-AROUND CASING HANGER

When the two halves are locked together, Gray's wrap around casing hanger immediately becomes a one-piece hanger. It embodies all the design and engineering principles gained through years of successful field use, plus the added ease of handling available in no other hanger. Wrap-around casing hangers can be furnished for either *Grayloc*® or flanged well heads. Write now for additional information and Gray catalog.

GRAY *Tool Company*

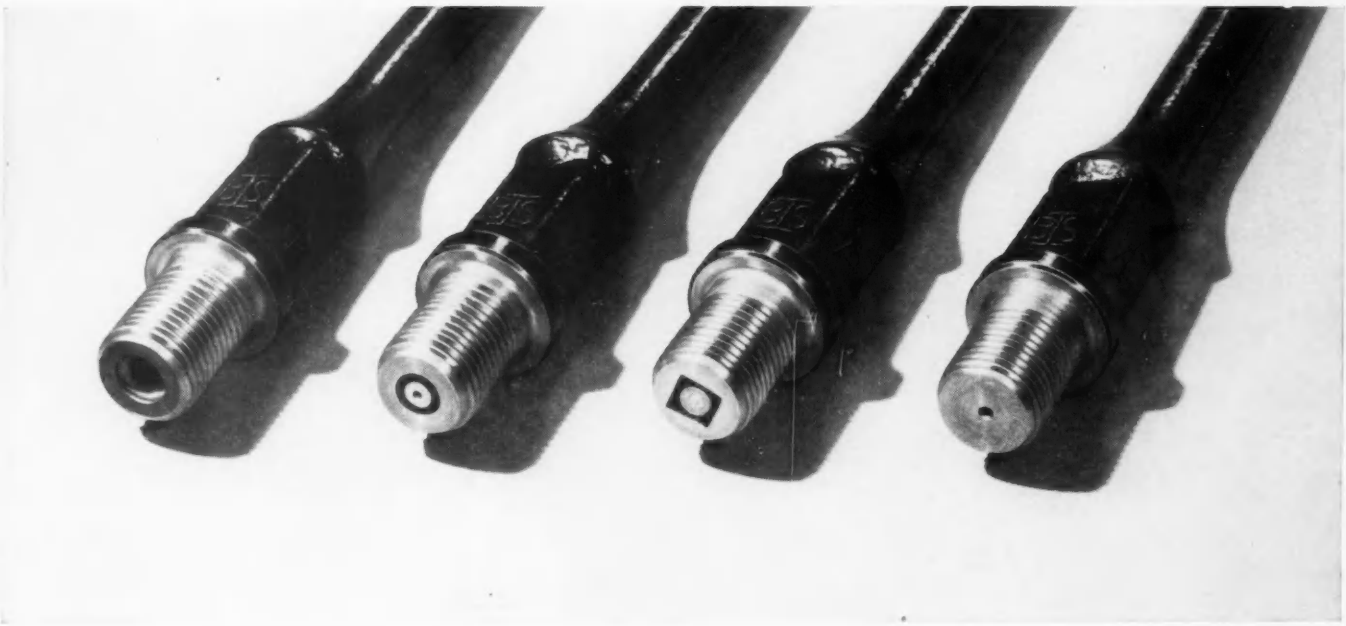
P. O. BOX 2291 • HOUSTON 1, TEXAS • RIverside 7-1240

6121

For economical pumping choose from four Bethlehem rods

Steel

for Strength . . . Economy . . . Versatility



These four types of Bethlehem sucker rods will handle a wide range of pumping conditions. You can count on them for long service because each rod is manufactured by modern methods, and is carefully inspected at several stages in the process.

To facilitate handling, Bethlehem sucker rods are shipped in a specially designed package containing 100 or 80 rods, depending on their size. Steel spacers separate the rods just enough to prevent contact with each other, thus protecting against damage in transit.

Should you have questions about the specific use of each rod, please call or write the nearest Bethlehem office. Or write to us at Bethlehem, Pa.

ROD	TYPE	HEAT TREATMENT	YIELD POINT psi		TENSILE STRENGTH psi	
			Min.	Av.	Min.	Av.
X2	Carbon-manganese	Normalized	65,000	72,000	93,000	100,000
X Mayari	Nickel-chromium	Normalized	60,000	65,000	90,000	95,000
46	Nickel-molybdenum	Normalized and tempered	67,000	75,000	82,000	90,000
41	Manganese-chromium molybdenum	Normalized and tempered	100,000	110,000	120,000	130,000

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

SIMPLIFY TREE CONSTRUCTION . . . AT LOWER COST

W-K-M Cross Type Multiple Completion Gate Valves

These compact multiple gate valves cost less than equivalent components and provide all of the service-proved features of regular W-K-M ® Gate Valves such as non-lubricated operation, Teflon* seat inserts for double-tight sealing, and parallel expanding gates for a positive up and downstream seal.

W-K-M Cross Type Gate Valves are available for dual, triple and quadruple completions. Specify W-K-M — at leading supply stores everywhere. Write for Catalog 200. W-K-M Division of ACF Industries, Inc. P. O. Box 2117, Houston, Texas.

*DuPont's tetrafluorethylene resin

When So Much Depends on a Valve . . . Specify W-K-M.

W-K-M DIVISION

ACF INDUSTRIES

Trinity
LITE-WATE

A Complete Low Density Cement with

EXCEPTIONAL COMPRESSIVE STRENGTH

Strength is recognized as one of the important qualities of an oil well cement slurry. TRINITY LITE-WATE cement develops exceptional compressive strengths.

In the range of lightweight cement slurries, TRINITY LITE-WATE produces a slurry which is:

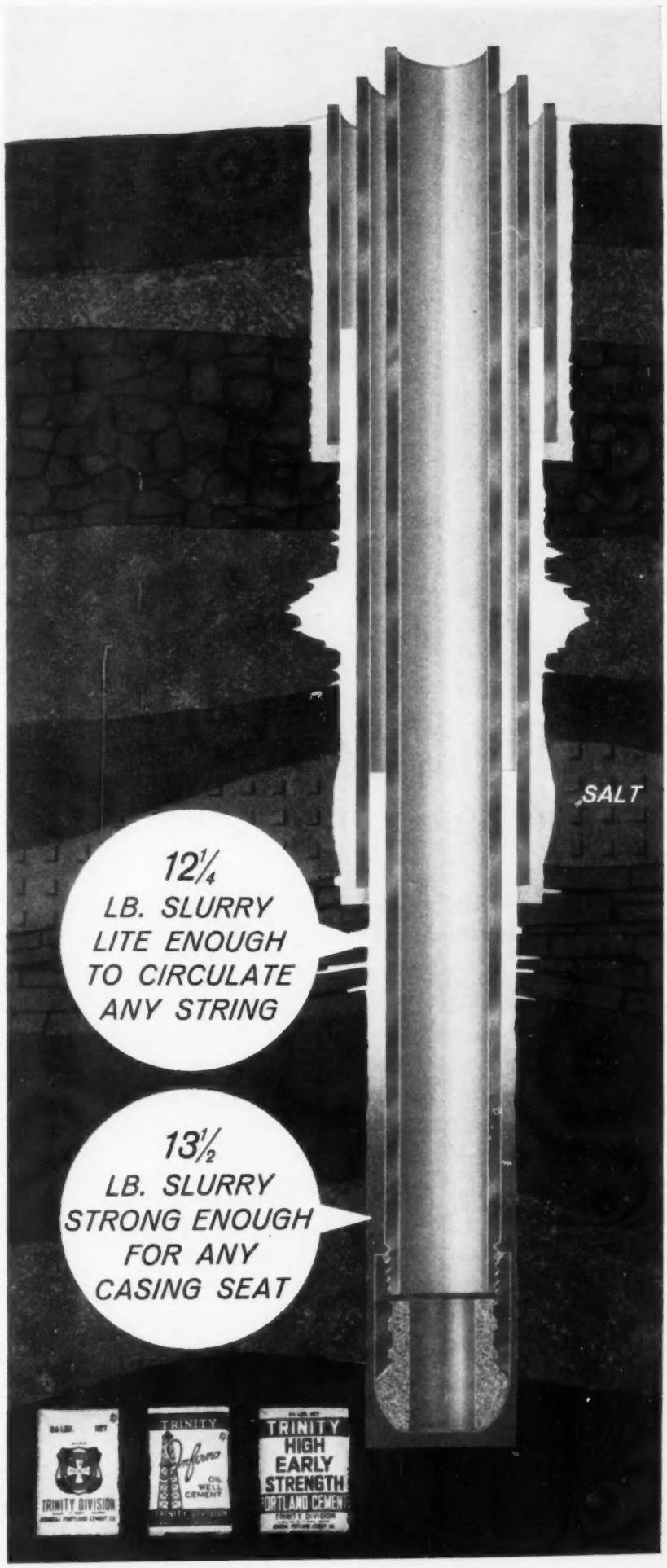
1. Light enough to circulate.
2. Strong enough for any casing seat.
3. Strong enough to permit hydraulic fracturing.
4. Impervious to migrating fluids.
5. Sulfate resistant for lasting casing protection.

For TRINITY LITE-WATE cement call your service company.

For complete Laboratory Data call your local Trinity Representative or write Dallas Office, P. O. Box 2698 or phone RIverside 2-8111.

376 lb. Barrel 94 lb. Sack

75 lb. Dry Volume per cubic foot


SALT
12¼ LB. SLURRY LITE ENOUGH TO CIRCULATE ANY STRING
13½ LB. SLURRY STRONG ENOUGH FOR ANY CASING SEAT
TRINITY DIVISION
TRINITY Inferno OIL WELL CEMENT
TRINITY HIGH EARLY STRENGTH PORTLAND CEMENT

TRINITY

PORTLAND CEMENT DIVISION
GENERAL PORTLAND CEMENT COMPANY

DALLAS·FT.WORTH·HOUSTON

For more data on advertised products, use Readers' Service Cards, last page.

this Dowell tool has revolutionized well completion, stimulation and workover practices

Seldom in the history of the oil industry has there been a tool as versatile as the one used in Abrasijet*.

By directing high-velocity streams of abrasive in liquid against casing or hole wall, Abrasijet can perform many jobs not previously considered practical. First and most important, Abrasijet can be used to cut slots in casing and formation at low cost. By moving the tool during jetting, either vertical or horizontal slots may be cut to reduce breakdown pressures and to initiate fractures in the direction and plane desired. This use of Abrasijet has resulted in excellent gas/oil and water/oil ratios as well as outstanding production increases.

Second, Abrasijet has been successful in perforating wells that could not be perforated using explosives. Several thicknesses of pipe and cement can be penetrated simply by adjusting the jetting time.

Third, Abrasijet can be used in old wells completed in open hole to clean formation faces that have become plugged with various soluble and insoluble deposits. Since Abrasijet is mechanical in action, a detailed chemical analysis of the plugging deposit is not required.

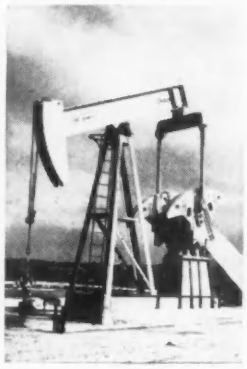
Finally, there is a special money-saving application of Abrasijet. A tool with downward-pointing jets can use acid without sand to dissolve set cement in casing or tubing. In many cases this is safer and less costly than drilling out.

For detailed information on this versatile service—call Dowell. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma. *DOWELL SERVICE MARK

SERVICES FOR THE OIL INDUSTRY **DOWELL**

DIVISION OF THE DOW CHEMICAL COMPANY

The "OILWELL" string...



PRODUCTS SERVICES STORES

When you buy from "Oilwell", you buy much more than a piece of equipment. You buy a function. You buy a means for drilling for oil or gas—or producing, transporting or processing it. With our products come services that make your job easier, your operation more profitable. Behind our products are services that work continually for higher quality, better design, and the assurance that when you buy from "Oilwell" you get the best in machinery and equipment. Stores and sales offices at over 100 points serving oil and gas operations in the United States and Canada round out the "Oilwell" string.

The "Oilwell" string even stretches to foreign lands where we provide representation in all oil and gas producing areas.

Turn the page for details about how the "Oilwell" string of products, services and stores assures you the most dependable source of supply in the petroleum industry.

USS Oil Well Supply
Division of
United States Steel

The "OILWELL" string...

PRODUCTS
SERVICES
STORES

99 years after the yellow dog

Not long after Col. Drake drilled his well, Oil Well Supply was in business and one of our earliest products was this "yellow dog," used for illumination. You can't buy a "yellow dog" from us today, but you *can* buy everything you need for the drilling, producing, refining and transporting of petroleum products . . . everything from a complete drilling rig to a handful of nails.

"Oilwell"-designed, -developed, and -field-tested machinery and equipment includes complete drilling rigs, surface and subsurface pumping equipment, reciprocating and centrifugal pumps, engines and compressors.

Distinct advantages to the user come from the fact that much of what we offer has been conceived and manufactured for the petroleum industry's specific needs.

In addition, "Oilwell" distributes the best of well-head equipment—valves and fittings—and all of the essential general running supplies, including USS National Tube pipe and USS Tiger Brand Wire Rope.

This wide range of own-make and selected vendor equipment, which we carry in stock, enables us to provide for our customers' needs whatever and wherever they may be.

USS and "Oilwell" are registered trademarks

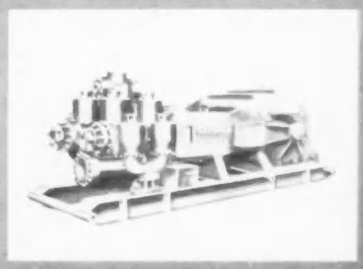
GARDNER-DENVER 1100 DRAWWORKS—A NEW CONCEPT IN DRILLING RIG DESIGN

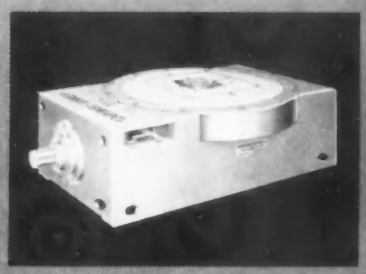
Unique in the oil field equipment industry, Gardner-Denver was able to build the 1100 drawworks without fear of obsolescence for older designs in the field. From the ground up, the 1100 drawworks is a unitized design with each part and detail selected to give a balanced drilling rig that will operate with maximum efficiency under longest and hardest drilling service. ☐ One of a full line of Gardner-Denver drawworks for drilling from 4,000 to 30,000 feet, the 1100 fits programs in the 8,000 to 15,000 foot range. Representative of the entire line, the 1100 design features a new concept of torque/speed combinations that give more usable horsepower and lower maintenance costs. Its short shaft and large bearing arrangement extends service life of these vital components. All controls, transmission and auxiliary brake are integrally mounted on the main skid for faster rigging-up and moving. GARDNER-DENVER

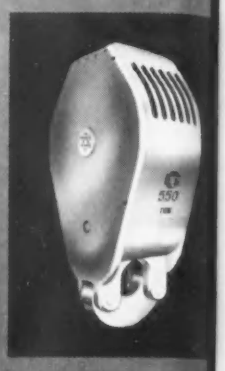
See next page

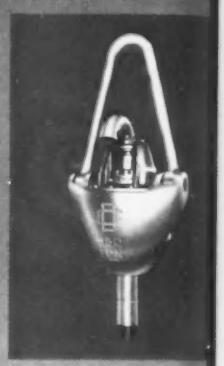
Gardner-Denver Company, Quincy, Illinois

Balanced/Engineered Drilling Team









Gardner-Denver drilling equipment has been designed as a matched team for greatest drilling efficiency. In addition to the drawworks and compound there is a swivel, block, rotary table, mud pump and compressor to match every drilling program.

MUD PUMPS

Gardner-Denver mud pumps have earned one of the finest names in the drilling industry. Ruggedly built, they have double helical gears, counter balanced eccentrics and are fully pressure lubricated for long life of moving parts. Pumps are available in sizes to match the Gardner-Denver 1100 drawworks in rating and capacity.

22½ ROTARY TABLE

Only Gardner-Denver rotary tables have Turbo-lubrication to increase the life of working parts. Turbo-lubrication cools and lubricates every moving part with a fast-moving stream of oil. Picked up from the large reservoir by the pinion gear, oil is force-circulated by the ring gear — then centrifugal action speeds the oil flow and distributes it evenly over the gears and main bearing. This large volume of cool oil adds thousands of hours of maintenance-free service to Gardner-Denver rotary tables.

RIG-MATCHED EQUIPMENT
FROM CROWN BLOCKS TO PUMPS FOR THE

1100

GARDNER-DENVER DRAWWORKS

Write for the 1100 brochure today!

300-TON TRAVELING BLOCK

Fast, true fall characteristics have been engineered into the Gardner-Denver line of traveling blocks. Unhampered by old designs or tooling, a new ratio of weight to rated capacity has been achieved. For faster falling, up to 2,000 pounds of weight has been added over competitive designs without increasing outside dimensions. For smooth operation, fabricated sheaves with perfect balance . . . both dynamically and statically . . . are used. Matching crown blocks available.

Gardner-Denver equipment combines imaginative engineering and modern technology with a century of experience.

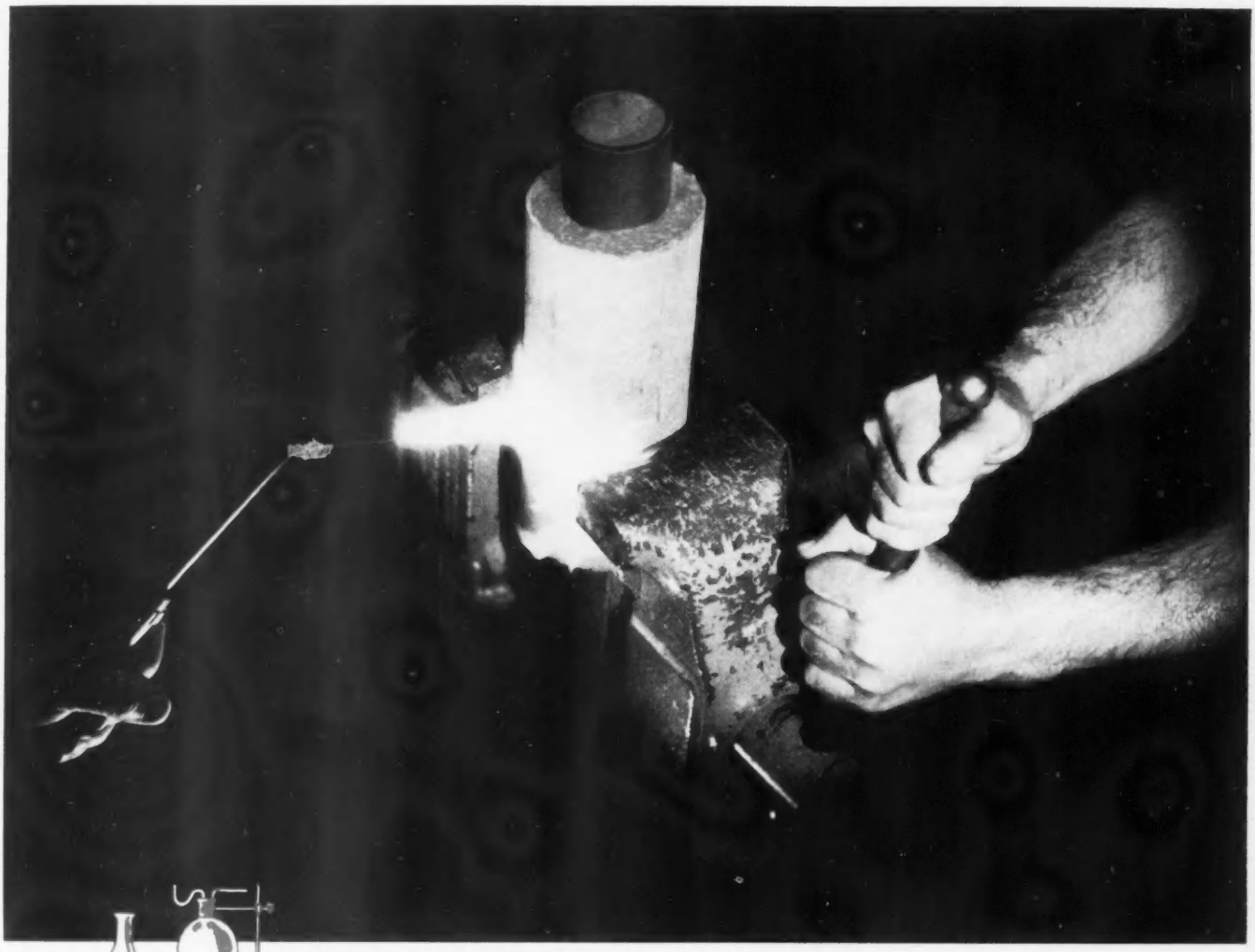
300-TON SWIVEL

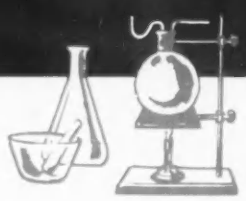
This new line of swivels is rated in "depth range" rather than in older terms of tonnage. This realistic concept is based upon actual field practice where depth, drilling load and speed are usually found consistent over a given drilling range.

Features: High pressure, easy change packing. Low center of gravity. High capacity bearings. Turbo-lubrication. Streamlined steel body for safety and strength.

GARDNER-DENVER

U. S. A. Gardner-Denver Company, Quincy, Illinois. Offices in principal U. S. Canadian and Mexican cities. Petroleum Products: Dallas, Texas. CANADA Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario. INTERNATIONAL Gardner-Denver International Division, 233 Broadway, New York N. Y. Offices: Buenos Aires, Argentina; Artarmon, N.S.W., Australia; Brussels Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Colombia; Lima Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal.





NEW STABILIZER

helps prevent loss of cement strength in hot holes

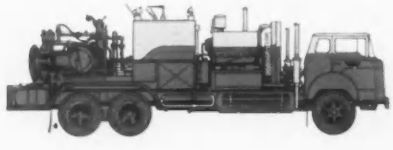
HALLIBURTON SILICA FLOUR now makes it possible to maintain or improve cement compressive strengths and keep cement permeability *low* in even the hottest wells.

Portland-type cements show drastic strength retrogression when subjected to high temperatures. A cement having a good compressive strength of 4,500 to 5,000 psi may lose *half* this strength in only 14 days exposure to high well temperatures. Silica Flour reacts chemically with the cement to help combat this strength retrogression.

Experience in cementing over 500 hot holes using blends of 20 to 40 per cent Silica Flour with retarded cements has shown impressive results in controlling strength retrogression and undesirable permeability increase. This additive is compatible with all commonly used cements, retarders, low water loss additives, weighting and lost circulation materials.

Lasting protection for your well requires lasting cement strength with low permeability. Investigate Silica Flour, another product development of Halliburton research . . . for cementing *any* well over 200° F. and for secondary recovery wells using steam or thermal drives.

. . . where advanced oil well cementing begins
—through research!



CEMENTING SERVICES

Halliburton
COMPANY · DUNCAN, OKLAHOMA

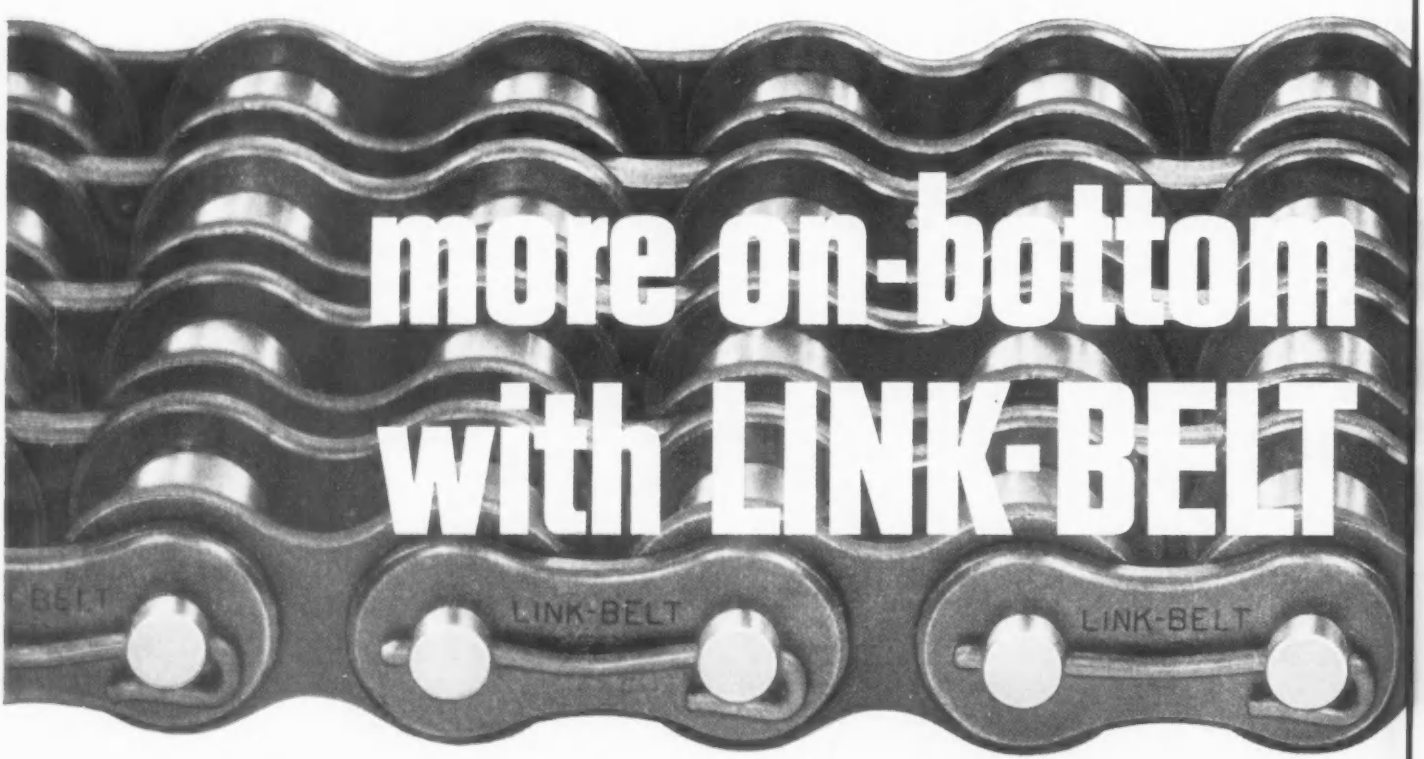
For more data on advertised products, use Readers' Service Cards, last page.

Multiple-strand prestressing —
Unless each strand carries its fair share of the load, multiple-strand roller chain may fail under the tremendous tensions and grueling conditions common to hard-working oil field drives. That's why Link-Belt's prestressing is so vital. Prestressing seats and cold-works the chain joint parts . . . assures equal load distribution across the chain, reduced elongation in service . . . adds extra measure of reliability.

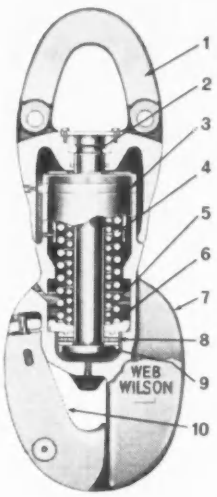
Exact heat-treat control—
To produce roller chain of utmost uniformity, Link-Belt maintains exacting control of all heat-treating processes. With equipment and instrumentation exactly tailored to the need, all processes are carefully adjusted to suit the characteristics of each heat and analysis of steel. Result: roller chain of uniform strength *well above accepted standards* . . . chain that delivers full power under continuous heavy going.

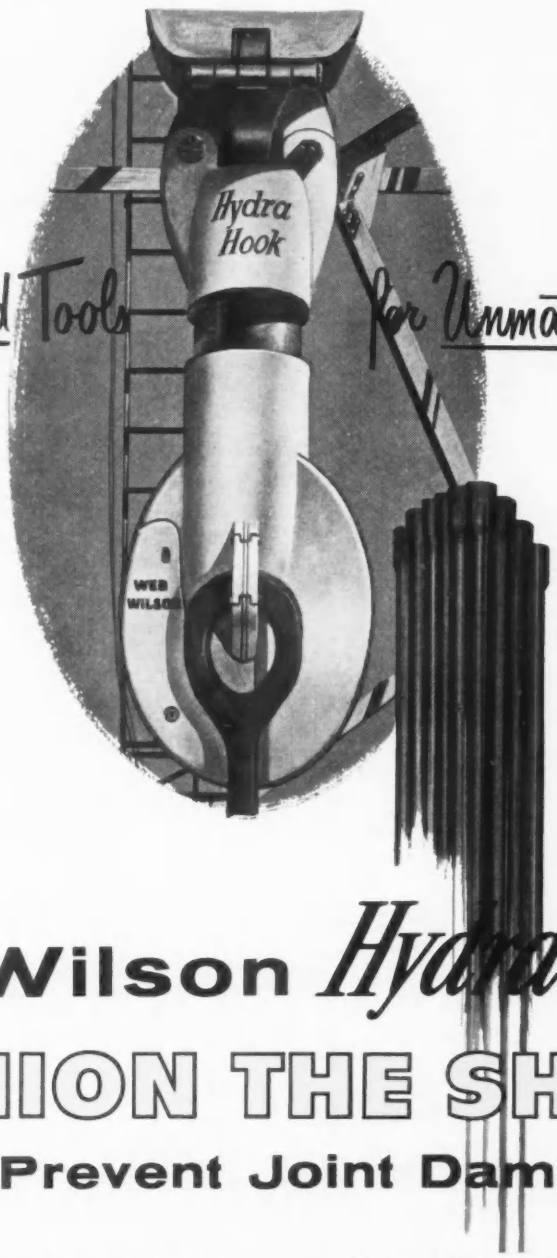
Optical comparator inspection—
Precision is *rigidly practiced* in every step of Link-Belt's roller chain production. The optical comparator, capable of magnification up to 100 times, is an example of the specialized equipment used to assure precise manufacturing control of chain parts and tools. Under its powerful magnification, Link-Belt chain parts and the tools that make them are continually checked to guard against flaws.

Manufacturing extras that add up to...



"Matched Tools for Unmatched Performance"





Web Wilson *Hydra Hooks*

CUSHION THE SHOCK

to Prevent Joint Damage

Every time a joint is made up or broken out, you benefit from the simple, foolproof shock absorbing hydraulic action of the Web Wilson Hydra Hook that prevents damage to threads and shoulders. Another distinct advantage—Hydra Hook is the shortest on the market—the least expensive way to add feet and inches of working height.

Economical operation and simple servicing are assured by these features: (1) Can be unitized or direct connected to all leading traveling blocks • (2) No load carrying threads—solid shank carries load • (3) 8 locked positions (12 in 450 ton) prevent rotation • (4) Less than 10 working parts • (5) Transported without draining oil • (6) Major internal parts enclosed in oil bath • (7) Parts are magnaflux inspected • (8) Large, staggered roller bearing, in oil bath for free swiveling • (9) No seals in hydraulic reservoir to leak • (10) Latch *cannot* open with load applied.

The WW Hydra Hook is another of the tools in the Baash-Ross line of "*Matched* Tools for *Unmatched* Performance" to speed operations at reduced expense.

See a Baash-Ross representative or the Composite Catalog for additional details.

OUR 42d YEAR OF PROGRESS

JOY

BAASH-ROSS

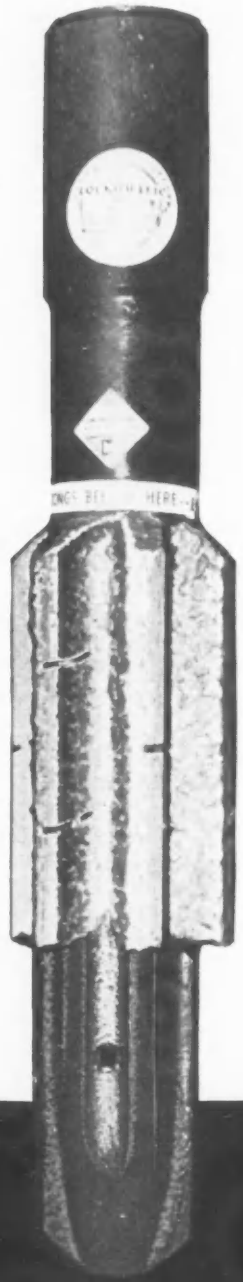
DIVISION OF JOY MANUFACTURING CO.

General Offices: Houston, Texas

For more data on advertised products, use Readers' Service Cards, last page.

Rotary Oil Tool Company

Jet Washing Cementing Tools



The Rotary approach to a better Plug Job and savings of rig time...

Do The Down-Hole Job In One Round Trip!

Doing the job in one round trip saves rig time. Jet washing removes the loose or soft formations, fractured cement and the mud ring. Immediately laying in the cement plug eliminates the re-build up of the mud ring—thus a perfect plug job is assured.

The ROTARY LMJC Tool
(Liner Mill—Jet Washing Cementing)

Jetting action taking place during the milling operation has no effect on the formation, for it takes place inside of the liner, well below the milling point.

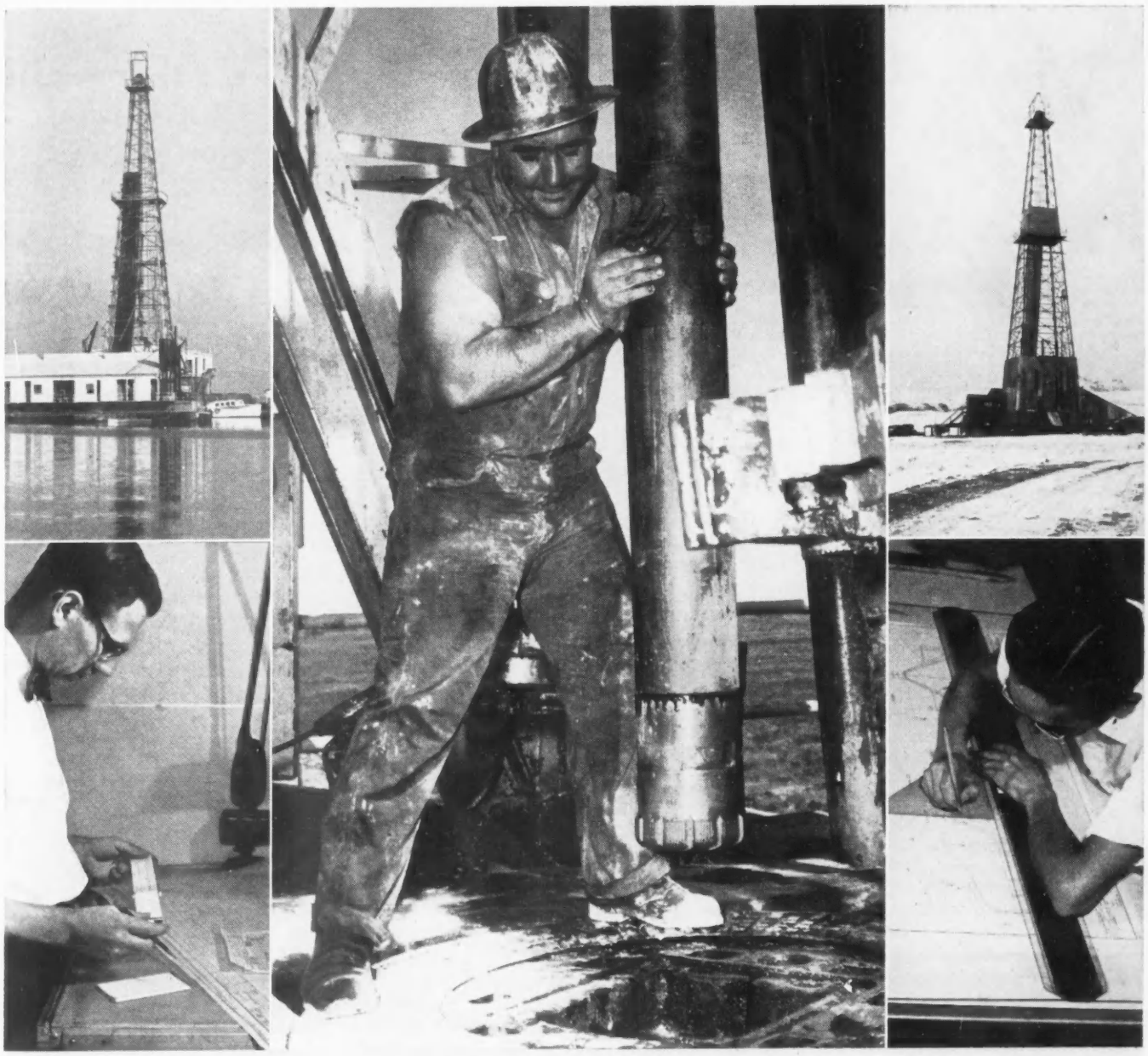
Available in all sizes

The ROTARY OIL TOOL COMPANY "Lockomatic" Expanding Tools have never been stuck in a hole, due to cuttings fouling the mechanism or failure to unlock. Rotary's "Lockomatic" Casing Section Mill will NOT hen-skin casing in high angle holes.

Rotary Oil Tool Company

Serving the industry over 20 years

8655 Whitaker Ave., Buena Park, Calif. • LAmbert 6-4621 • Cable ROTOILTOOL



Operate at "Less cost per foot"

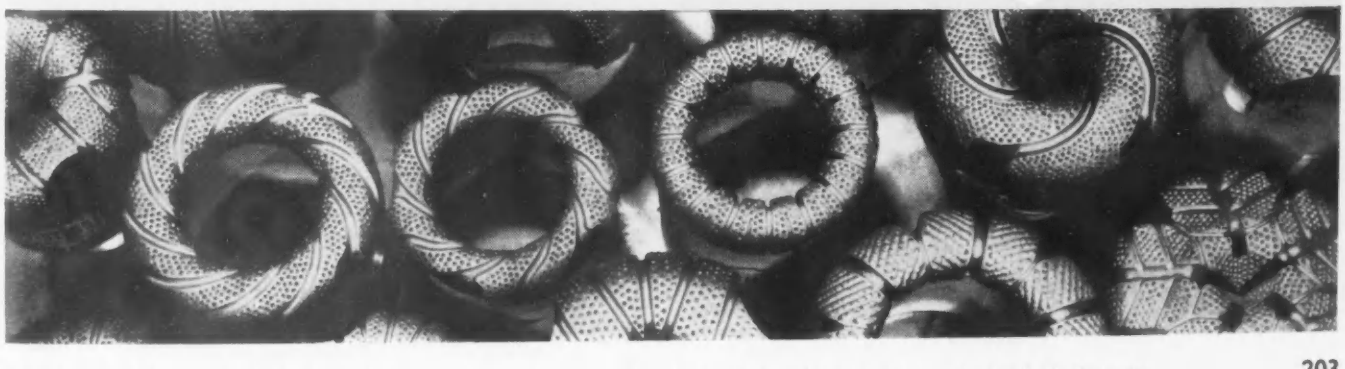
With manufacturing plants throughout the world Christensen can design and deliver your "engineered" diamond bit, on time, regardless of your job location.

"Less cost per foot"

CHRISTENSEN DIAMOND PRODUCTS

MAIN OFFICE AND PLANT 1937 SOUTH 2nd WEST
SALT LAKE CITY, UTAH

SERVICE FROM WORLD-WIDE SALES OFFICES AND MANUFACTURING PLANTS



. . . New Safety and Service in

NOWSCO originates use of safe, economical liquid nitrogen for Fluid Displacement . . . Acidizing and Fracturing . . . Corrosion Inhibition . . . Nitrogen Sand Drill . . . Full Bore Tool . . . Perforating . . . Testing . . . Drilling . . . Drill Stem Testing

On December 17, 1959, in the South Dayton Field near Houston a new chapter in the development of oil field processes was written.

This new process utilized a here-to-fore wasted natural element of our atmosphere. The element was nitrogen. The use of liquid nitrogen opened the door on a new horizon of services for the petroleum industry.

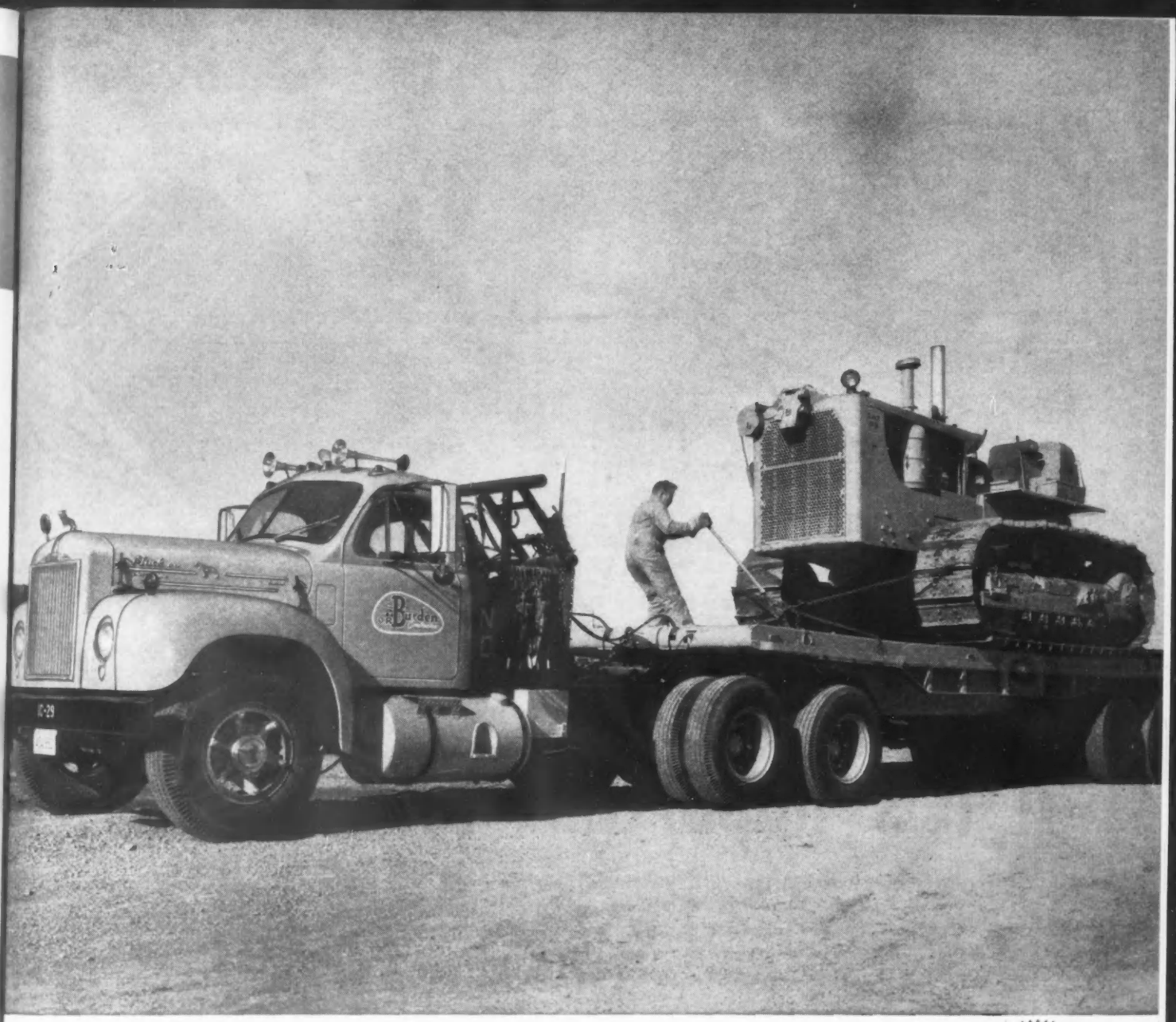
Nitrogen Sand Drill. Injecting high-pressure gaseous nitrogen into the fluid sand carrying stream has recently proved appreciable increase in penetration in all types of formations. Extensive field tests have been run on wells ranging from 2,000 feet to 11,000 feet with various concentrations of sand, water and nitrogen.

Full Bore Tool. Where a series of down hole treatments or tests are to be performed either after squeezing or perforating, the aid of high-pressure nitrogen to displace well or treating fluids in the drill string or tubing provides quick, safe and economical evaluations.

Inflatable Packers can be set with nitrogen and CEMENT PLUGS used in tubingless completions can be easily pumped down with nitrogen.

Completely self-contained transport and pump truck units are ready for service day or night. A one-inch steel hose is the only connection between truck and well. Pump pressures up to 10,000 psi are fully controlled by the driver-service man at the truck. A heater on the truck converts the liquid nitrogen to the gaseous state. Transport provides 5200 gallons to continually supply pumper.

NOWSCO service men are experienced oilfield workers who have been thoroughly trained in all the many uses of nitrogen for the oil industry. They carefully calculate and control injection rates, pressures and volumes of nitrogen required to successfully service each well.



ALL IN A DAY'S WORK—Turbocharged Thermodyne diesel-equipped Mack has power to spare for hauling the oil-field tractor being pulled down in the pipe yard of O. R. Burden Construction Corp. Company selected this Mack six-wheeler after 17-Mack fleet in Iraq and its domestic fleet proved unequaled in economy, durability and performance.

MACK for over 8 straight years NO. 1 by far in sales of diesel trucks

IT HAD TO BE MACKS!

"In September, 1959, our company was awarded a contract for construction of 317 miles of pipeline in Iraq," says Mr. J. S. Burden, president of O. R. Burden Construction Corp., Tulsa, Okla.

"After careful study of the hauling requirements for this project, and as a result of our domestic trucking experience, we chose Mack trucks over all competitive makes for our medium and heavy transport needs. We certainly made the right choice.

"We've found pipeline construction hauling everywhere is more efficient with Macks on the job . . . and their excellent performance overseas and in this country certainly influenced us in our latest purchase, a 72,000-lb. GCW Turbocharged Thermodyne® diesel-powered Mack B Model tractor," says Mr. Burden.

What are the reasons behind Mr. Burden's high opinion of Mack trucks? Some are: eight miles per gallon of fuel with full loads of pipeline construction equipment . . . minimum downtime despite the rigors of remote construction jobs in the United States and in the Persian Gulf area . . . and Macks' ability to stand up and come back for more regardless of terrain, weather or service.

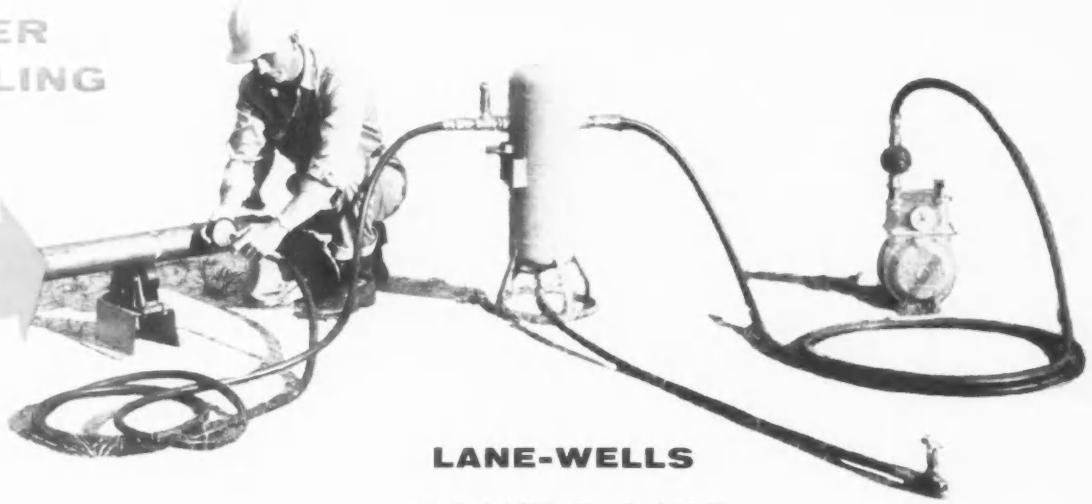
You can have the most dependable, economical truck transportation, too. Simply call in your nearby Mack representative. When you've heard the full story, you'll agree "It has to be Macks!" Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario.

8087

MACK
FIRST NAME FOR
TRUCKS

If it's important to oil men . .

SAFER, SURER
FLUID SAMPLING



LANE-WELLS

DOUBLE SAFE

FORMATION TESTER

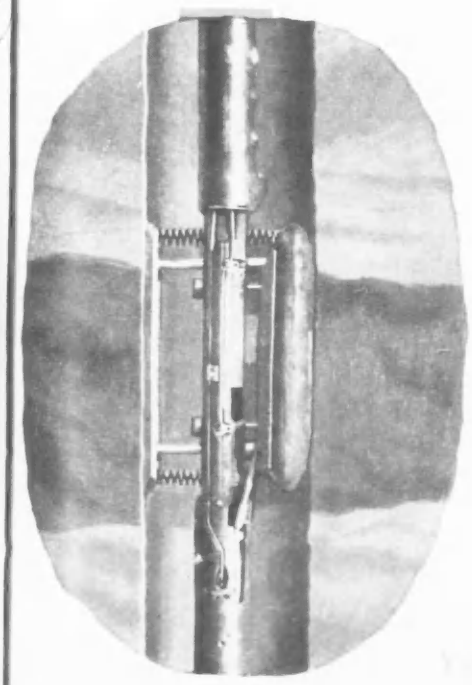
- Complete film record of hydraulic, formation and hydrostatic pressures.
- All valves operated electrically from surface.
- Two equalizer valves for positive release.
- Two part sampling for accurate interpretation with safety.

The Lane-Wells wire line Formation Tester obtains both formation fluid samples and valuable pressure data with a new level of safety never before possible.

This tool may be used at any time during drilling. It is positioned by correlation with an SP curve. After the sealing pad and back-up shoe are set and held by hydraulic pressure, access of the formation is obtained by means of a Koneshot charge.

When the sample is obtained and sample chamber closed, the pad is retracted by releasing hydraulic pressure, the tool withdrawn and sample transferred through high pressure hose to a calibrated separator and gas meter. The measured quantities of fluids and gas provide an index to the production potential of the formation tested.

A complete film record of hydraulic pressure in the sealed section, formation flowing and shut-in pressures and hydrostatic pressure of the borehole fluid provide additional valuable information.

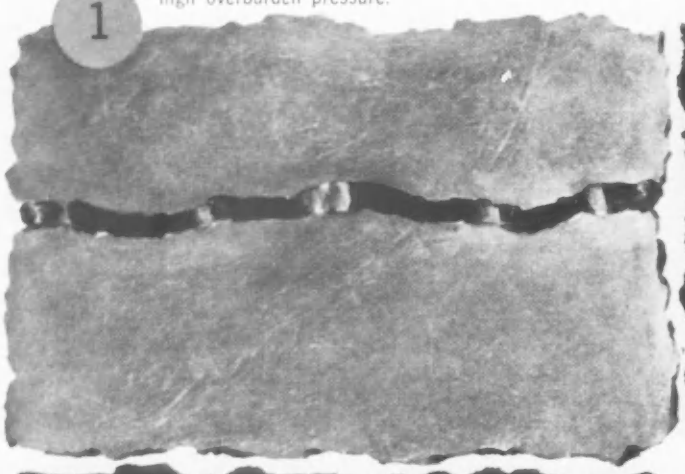


LANE-WELLS CO.
HOUSTON, TEXAS
LOGGING · PERFORATING · PACKERS · BRIDGING PLUGS

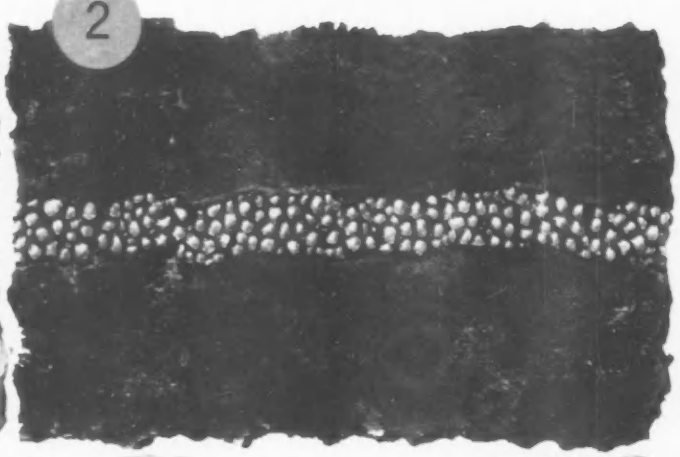
DRESSER INDUSTRIES, INC.
OIL · GAS · CHEMICAL · ELECTRONIC · INDUSTRIAL

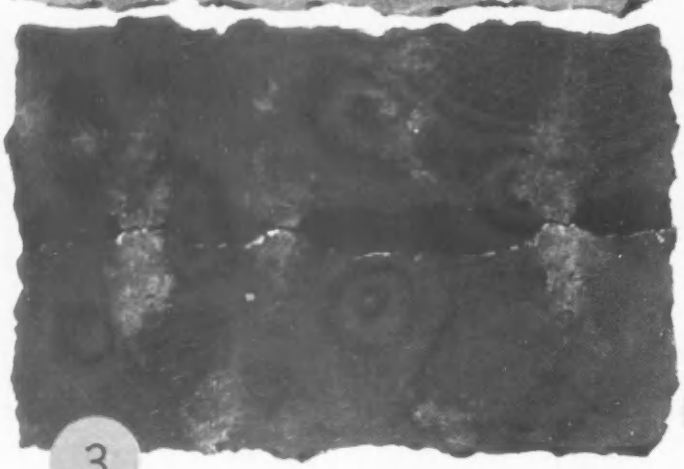
ONE OF THE DRESSER INDUSTRIES

Widely-spaced malleable props, such as rounded walnut shells, propping a fracture in a hard homogeneous formation with high overburden pressure.

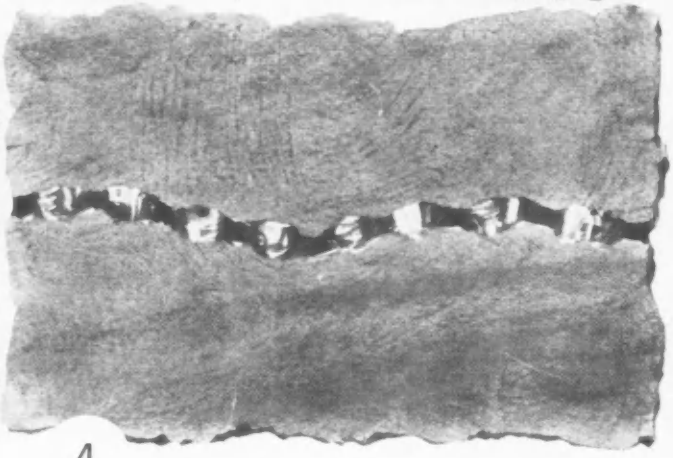


Sand fully packed into a fracture in a homogeneous formation with low permeability and moderate overburden pressure.





No prop is used in an acid-soluble, heterogeneous formation. Retarded Acid etches formation, leaving less soluble portions as prop.



Closely-spaced malleable props, such as aluminum pellets, propping a fracture in a medium-hard to soft homogeneous formation with high overburden pressure.

fracture conductivity tests help operators select most profitable stimulation treatments

For more than a year, Dowell laboratories have been measuring and compiling data on flow capacities of fractures in various formations. The effects of different fracturing fluids and propping agents on fracture conductivity are compared. The illustrations here show four examples of fracture props that are frequently checked.

Flow capacity data from these tests — plus other pertinent well information — are interpreted through the Frac Guide* by Dowell engineers to help design the most profitable fracturing treatments for you.

In many cases, operators have realized much faster payouts than had been recognized as normal for a field. In some instances, Dowell has helped operators avoid many unprofitable jobs. In most cases, average profits have been increased over previously accepted norms.

In designing a stimulation treatment, it is best to test actual cores from your well. However, if cores are not available, cuttings can often be used. These cuttings are compared for similarity with the numerous cores already tested and cataloged by Dowell.

Ask your Dowell representative for a free copy of the new "Technical Report on Fracture Conductivity." It deals with such factors as size, type and amount of propping agent, hardness of formation and overburden pressure.

The fracture conductivity testing program is another important step in Dowell's continuing research and service program to help you make more profits. Dowell services and products are offered in North and South America, Europe and North Africa. Dowell, Tulsa 1, Oklahoma.

*DOWELL SERVICE MARK

SERVICES FOR THE OIL & GAS INDUSTRY

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY